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ENGINEERING REPORT
FOR
COMPARISON OF COSTS
OF
ALTERNATE LINES
ON
INTERSTATE ROUTE 90

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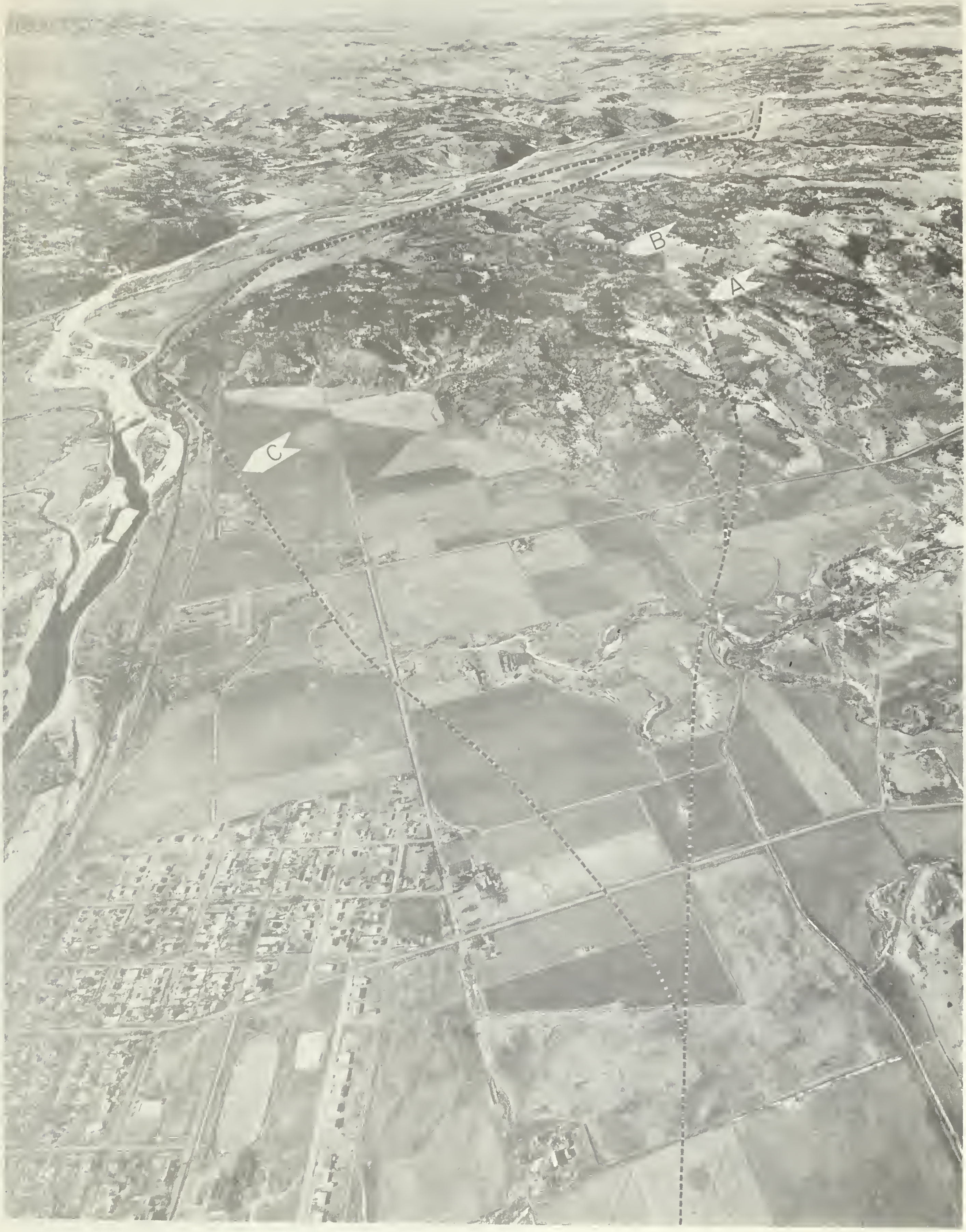
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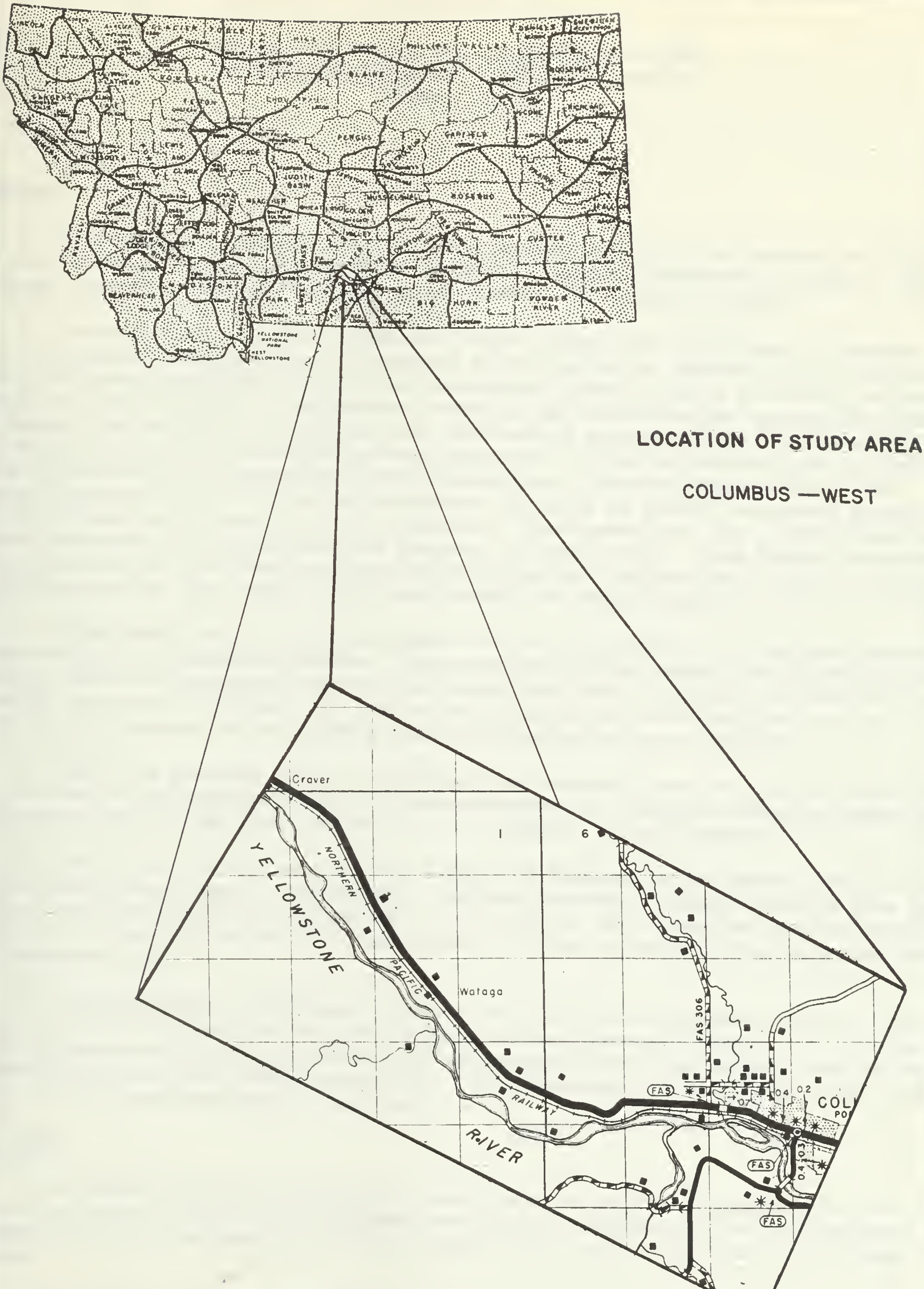

LOCATION OF STUDY AREA

COLUMBUS —WEST

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ENGINEERING REPORT FOR COMPARISON OF COSTS OF ALTERNATE LINES ON INTERSTATE ROUTE 90
COLUMBUS WEST

FOREWARD

The Interstate System was originally established under the Federal Aid Highway Act of 1944. It was defined as the National System of Interstate Highways. This original system was included as part of the Federal Aid Primary System.

However, the nation-wide interest in the Interstate System made it evident that it required special attention, both in financing and in expediting the construction to adequate standards to serve the anticipated great increase in traffic volumes. Action to accomplish this objective was contained in legislation as part of the Federal Aid Highway Act of 1956. Under this Act, the name of the system was changed to the National System of Interstate and Defense Highways. It was stipulated that the Interstate System should be completed as practicable over a thirteen-year period. The national interest in the system was recognized by means of greatly increased authorization of Federal Aid to assist in construction of the system and, also, liberalization of the proportion of Federal money as compared to State money. Much higher standards were prescribed for the construction of this system and included the control of access to the highways so that traffic could move safely and expeditiously.

This report was prepared to compare the relative merits of alternate locations in the vicinity of Columbus, Montana. The principal purpose here is to illustrate in monetary terms the most pertinent considerations involved, including the cost of constructing alternate locations, the cost of maintaining each location, and the cost which will be incurred by the highway user in traveling on each location.

Since the cheapest route to construct and maintain does not always provide the best service to the highway user, it is also necessary to consider vehicular operating costs in determining the route which is of the greatest overall benefit.

Federal and State funds for the support of highways are obtained almost entirely from highway-user taxes; consequently, the most favorable highway location from the standpoint of the people who are paying for it would be the route that has the lowest overall cost when all construction, maintenance and vehicular operating costs are taken into consideration.

The development of Montana's 1200 miles of Interstate Highways requires that a section be built in the vicinity of Columbus in south central Montana. It is to be a link in Interstate Highway 90 which will ultimately extend from Lookout Pass on the Montana-Idaho state line, through Missoula, Butte, Bozeman, Big Timber, Billings, and Hardin, to the Montana-Wyoming state line.

STUDY AREA

The study area is in Stillwater County in south central Montana. The area immediately around Columbus is irrigiated cultivation, bordered on the east and west by rugged hills, on the south by the Yellowstone River, and on the north by rolling terrain.

As shown on the accompanying situation map, study termini are located on US 10, 8 miles west and immediately north of Columbus.

AREA HISTORY

The area was traversed in 1806 by Lewis and Clark as they journeyed up the Yellowstone River, by John Coulter, scouting for furs in 1807, and by Captain Bonneville, in 1830. The trails blazed by Jim Bridger, in 1860, and John Bozeman, in 1863, brought many settlers into the area.

In 1873, Horace Countryman, C. H. Countryman, and W. H. Norman, opened a trading post near the confluence of the Stillwater and Yellowstone Rivers and carried on trade with the Indians, trappers, frontiersmen and farmers. This trading post became well known in the area and was used as a stage station and post office, which, in 1877, was given the name of Stillwater. With the construction of the Northern Pacific Railway tracks on the opposite side of the Yellowstone River in 1882, Horace Countryman and his partners moved to the present site of Columbus and platted a new village that also was given the name of Stillwater. As mail began to move on the Northern Pacific, this name was changed to Columbus to avoid confusion between Stillwater, Minnesota, and Stillwater, Montana, by postal clerks. Stillwater County was created on March 24, 1913, from the west portion of Yellowstone County, the north portion of Carbon County and the east portion of Sweet Grass County, and Columbus was named the county seat.

AREA ECONOMY

The principal industry of the county is raising livestock. The higher areas near the mountains in the southern part of the county produce alfalfa and hay as leading crops. In the dry land farming area in the northern part of the county, wheat is considered the leading crop. In the irrigated lands along the Yellowstone River, the principal crops are alfalfa, sugar beets, beans, and small grains. These crops also support livestock feeding operations in this area.

The southern part of the county has a large timber acreage suitable for lumbering. This supports numerous mills and a laminated beam plant.

The southern part of the county also contains extensive chromium deposits, developed during World War II, when overseas sources were inaccessible. Two mines, the Binbow and Mouat, were completely developed, including milling and housing facilities. The development was shut down after shipment of chromite ore from North Africa was resumed; however, the area is a potential source of intensive development.

The population of Stillwater County in 1960 was 5,526, of which 23% were residents of Columbus. Columbus, as the county seat, is the center of activity for Stillwater County. It has a small, but well developed business district, capable of furnishing complete agricultural, commercial, and medical services to the surrounding area, as well as being its transportation hub.

During the summer months, Columbus is the gateway to an extensive recreational area to the south.

DESCRIPTION OF ROUTES

As shown on the map in the front of this report, three alternate locations for Interstate Highway No. 90 were selected for detailed study. All three alternate routes begin at the West Common Point which is the termination of the presently constructed Interstate Highway at Springtime. All proposed Columbus-West routes extend east from

Springtime, and terminate at the Columbus Interchange, designated as the East Common Point.

The A Route represents the shortest route practical, subject to small deviations imposed by terrain features. The B Route was selected with the intent of increasing the travel distance slightly to take advantage of less difficult terrain. The C Route was selected closely paralleling the PTW (U.S. Highway No. 10). This route is the longest of the alternate routes studied but would involve less earthwork for construction.

Access to the county road near the west terminus is provided by an interchange at this location on Line A and Line B. On Line C, access is via a separation and the present highway from an interchange near Benson's Bluff.

Secondary 307 is separated on all lines.

The Columbus Interchange, though not included in this study area, would allow traffic to get off the Interstate Highway for stops in Columbus.

Any of the routes studied would be constructed as a 4-lane highway with control of access restrictions as specified for Interstate standards.

ALTERNATE ROUTE A

The A Alternate begins at the West Common Point at Springtime, and proceeds east for a short distance along the PTW to where the existing highway curves to the south. At this point, the A Route leaves the PTW and continues straight across a field, then begins to ascend up a coulee into higher, more hilly country. The line crosses several relatively deep drainages where adverse grades must be used to minimize cut and fill heights. The line is slightly curved to take advantage of hillside grade support where possible. The roadway would gain 425 feet of elevation from the bottomland to reach a summit elevation of about 4085 feet before beginning its decent back down to the flatter country northwest of Columbus. The line then crosses irrigated farmland for a short distance and joins the Alternate Route B, then Alternate Route C before reaching the East Common Point near the Columbus Interchange.

The A Route, by staying in hilly country, traverses very little farm land. The country it crosses is unpopulated and is used primarily for the purpose of grazing livestock.

The total length of the A Route is 7.64 miles. The minimum design speed is 50 mph and the maximum grade is 5 percent.

ALTERNATE ROUTE B

The B Alternate begins at the West Common Point near Springtime, where it ties to the presently constructed Interstate Highway. It remains to the north of the existing highway, paralleling the same for a distance of slightly more than 2 miles. The B Route then swings to the east, leaving the existing highway and crosses some farmland to begin ascending up a small drainage and gain elevation. It is quite curvelinear for part of its length to take maximum advantage of terrain features and decrease earthwork quantities. The proposed route climbs about 370 feet from the bottomland and reaches a maximum elevation of about 4010 feet. It then descends on the south slope of a small drainage to tie in with the A Route at the west edge of the cultivated land by Columbus.

The A and B Routes are common from this point to the Columbus Interchange.

The B Route crosses fields for about 1½ miles to avoid some of the more rugged country traversed by the A Route. After leaving the farmland, the B Route passes through umpopulated grazing land as does the A Route.

The B Route is 8.18 miles in length with a minimum design speed of 50 mph and maximum grades of 5 per cent.

ALTERNATE ROUTE C

The C Alternate begins at the West Common Point and closely parallels the existing highway to the north. It leaves the PTW in place as a south frontage road to serve local raods entering from the south side. A new frontage road must be built for about 3 miles on the north side of the Interstate west of Benson's Bluff, to accommodate local roads entering the PTW from the north. Vehicles using the north and south frontage roads would gain access to the Interstate Highway at an interchange west of Benson's Bluff, and could travel to Columbus on the Interstate Highway. This interchange is justified in view of extreme excess excavation that would be required to construct frontage roads around Benson's Bluff.

A complicated construction problem exists in the vicinity of Benson's Bluff. Evidence of bank failures indicates that relatively flat slopes should be maintained in constructing the C Route at Benson's Bluff. Maintenance of the Columbus-Merrill Ditch in this vicinity complicates the problem. Extensive flume construction, piping, and/or channel changing will probably be necessary to maintain operation of the ditch. Extreme care will have to be taken to ensure that no leakage occurs which could saturate the embankment and cause embankment failure.

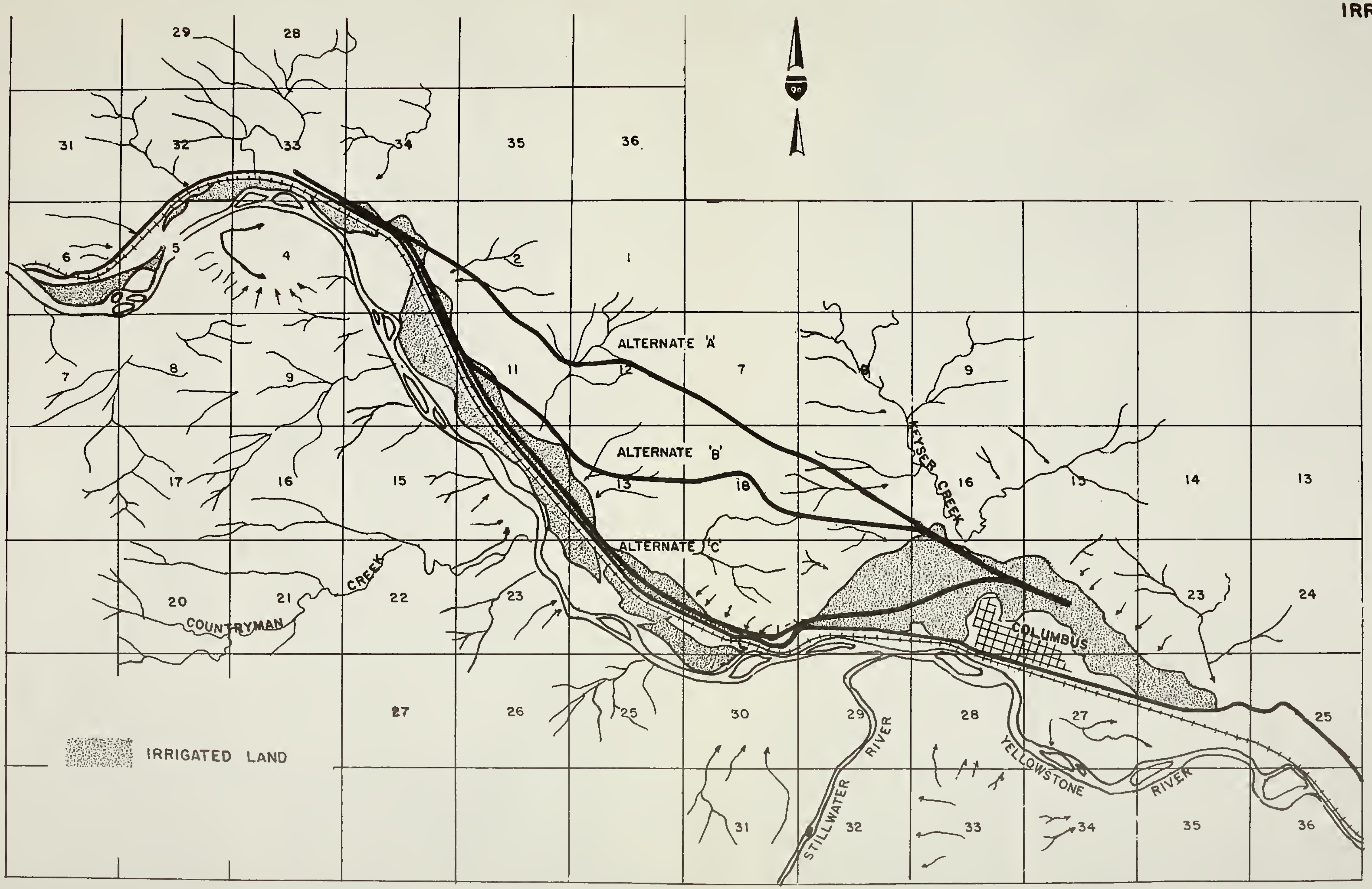
Immediately east of Benson's Bluff, the C Route swings north of the existing highway across irrigated farmland and is north of Columbus, where it terminates near the proposed Columbus Interchange.

The C Route is on irrigated farm land for its entire length with the exception of the vicinity at Benson's Bluff. Immediately west of Columbus it serves a number of cultivated farms in order to skirt the residential district of Columbus.

The total length of the C Route is 8.70 miles. There is a short length of 5 per cent grade east of Benson's Bluff where the design speed is limited to 50 mph. The remainder of the distance between common points entails only mild grades and could be built to 70 mph design standards.

IRRIGATION & DRAINAGE

COLUMBUS — WEST



The following table presents a comparison of the principal construction features involved in each of the alternate Columbus-West routes.

	A ROUTE	B ROUTE	C ROUTE
Route Length (Miles)	7.64	8.18	8.70
Miles of 4-lane Construction	7.64	8.18	8.70
Miles of New Frontage Road	0.33	0.33	2.50
Number of Interchanges	1	1	1
Number of Highway Separations	1	1	2
Maximum Grade	5%	5%	5%
Grade Length 3% and Over (Miles)	3.79	3.19	0.93
Percent of total length	49.7%	39.0%	10.7%
Grade Length 4% and Over (Miles)	3.35	2.88	0.93
Percent of total length	43.8%	35.2%	10.7%
Grade Length of 5% (Miles)	1.96	2.39	0.38
Percent of total length	25.7%	29.2%	4.4%
Total Rise and Fall (Ft.)	976	818	313
Rise and Fall in ft./mi.	128	100	36
Maximum Elevation of Route (Ft.)	4085	4010	3707
Maximum Depth of Cut at Catch (Ft.)	185	153	244

From the preceding table, it may be observed that the A Route is about 1.06 miles, or 12% shorter than the C Route and about 0.54 miles, or 6.7%, shorter than the B Route. The table reveals that the total length of any route would be constructed as a 4-lane highway as warranted by the 20-year design traffic volumes on all sections in the study.

The C Route involves construction of 2.50 miles of new frontage roads as compared to 0.33 mile on either the A or B Routes. The greater length of frontage road required on the C Route is due to more complex local access features.

All routes involve maximum grades of 5 per cent. However, the C Route has only 0.38 mile of 5% grade or about 20% that of the A Route and about 16% that of the B Route. The table indicates that the C Route involves about 32% as much grade over 4% as does the B Route and about 28% as much as does the A Route. In general, it can be seen that the C Route entails quite favorable grades as compared to the two more northerly routes. Routes A and B involve, in general, quite similar grade features.

Since the hills in the study area tend to rise to the north, the A Route crosses at the highest summit elevation. The highest point on the A Route is at about 4085 ft. of elevation. This elevation is about 75 feet higher than the highest point on the B Route and about 378 feet higher than the high point around Benson's Bluff on the C Route.

Although the A and B Routes in general involve heavier earthwork than does the C Route, the C Route has one cut which has greater depth at the catch point than have maximum cuts on either the A or B Routes. The maximum depth of cut on the C Route occurs around Benson's Bluff where the left slope catches 244 feet above the roadway ditch bottom. This figure indicates a maximum cut depth which is about 59 feet greater than the greatest on the A Route and about 91 feet greater than the greatest on the B Route.

GEOLOGY OF THE AREA

A general evaluation of the soils and geology of the area was made and all of the lines were carefully examined on air photos and inspected on the ground. The geology of this area is relatively uncomplicated. Although they will not negate any of the proposed lines, the soils and geology must be taken into account in comparing the various lines. The soils and geology examination was in sufficient detail to permit comparison of various lines, but more work will be required for design on the line which is finally selected. A general description of the geology and soils, below, is followed by a more detailed analysis of each line.

GENERAL GEOLOGY

The upper Cretaceous sedimentary rocks exposed in the area are nearly flat-lying despite several relatively large structures--few dips of more than 7° were measured. Deposits of gravel occur along both sides of the Yellowstone River and the River has created numerous steep bluffs along the valley. The river-developed topography has a decided effect on any line adjacent to the river.

The major formations exposed in the area are shown graphically described and their exposures in the area are shown on the geological exhibits. The thicknesses and descriptions have been modified to include local conditions in the study area. The most noticeable "local" feature is the thinness of the Bearpaw shale.

The development of the soils in the area varies with both bedrock type and topography. The uplands west of Columbus have a thin soil cover with numerous outcrops of Hell Creek sandstone. On ridge tops, the numerous flats developed on local sandstone beds attest to the thinness of the soil. In the large gullies, there are accumulations of slope debris, but even here the soils are not thick. The soils are derived from shales and soft sandstones of the Hell Creek formation with numerous pieces of soft to medium-hard angular sandstone gravel; their classification is generally A2-4 to A-4.

The soils along the valley are very different from the upland soils and much more pertinent to the selection of a line. In general, they are composed of the finer and more deleterious ingredients of the bedrock. Classifications range from A2-4 under bluffs to A6(12) in swampy areas. Although river deposits of gravel may underlie much of the area, they are exposed in only a few places and elsewhere have little apparent effect on valley soil development.

Both surface and subsurface drainage in the uplands are generally good. The lowland soils, however, have low permeability which results in poor subsurface drainage. Lowland surface drainage is generally fair, but for some areas the combination of railroad and highway embankments results in poor surface drainage. Cut-off stream channels have no surface drainage. Drainage is complicated by irrigation of fields adjacent to the roads.

Effect Of Geology And Soils On Alternate Lines

All of the material originating in the major cuts on these lines will make satisfactory embankment. The Hell Creek beds are nearly flat-lying and consist of sandstone beds from 2 to 20 feet thick and somewhat fewer shale interlayers with a similar range of thickness. The shale begins to disintegrate slowly and assumes a stable slope of approximately 1.75:1. Despite the apparent competence of the sandstone, numerous fractures make it susceptible to undercutting. Abundant rock fall problems in areas with slopes steeper than 1:1 attest to the necessity of using the shale stability as a guide to cut slopes, or providing safety precautions controlling rock fall.

These precautions, where slopes are steeper than 1.5:1, may include either benches or ditches designed to prevent rocks from reaching the travel area.

Line A traverses the Hell Creek upland area from station 615 to station 870. Except for some soft foundation in old channels at stations 555 and 567 (common to all three lines), there are no apparent slope or foundation stability problems on the A line.

In addition to the poorly drained channels at stations 555 and 567, B and C lines are adjacent to intermittent, very soft foundation sections in the ditches of the present highway and under the irrigation ditch near station 650. However, as the lines are presently located, they will skirt these areas and avoid foundation problems. In the cut section between stations 650 and 660, water and frost damage can be prevented by lining the ditch or by providing draining sub-base.

The sidehill soil development is thin and discontinuous so that a slide plane cannot develop along the present surface. Line B parallels the existing highway to station 660; from there to about station 747, it is on relatively good soil along the edge of the valley; from station 747 to station 800 it traverses the same uplands as line A and crosses the summit at approximately the same elevation. The same cut slope requirements will apply to lines A and B in the Hell Creek formation uplands.

Line C is essentially parallel to the present highway to station 897 where it crosses the valley alluvium south of Columbus. Poor drainage areas on portions of the line common to A and B alternates have already been mentioned. Although there is only one large cut on the C line, it is in a section of the existing highway which has been susceptible to rock fall and small slides. The situation is complicated by a large irrigation ditch which has required special treatment. In the west half of the cut, the materials are sandy and shaly rubble. Any new line through here should continue to handle the irrigation water so no leakage will occur in the roadway area.

Summary of Geologic Aspects

No geologic conditions exist on any of the study routes which by themselves negate an alternate route. Therefore, economic considerations were used as the basis for evaluating the effects of geologic features in selecting a route. Estimated construction costs in this report reflect considerations imposed by geologic problems unique to each of the alternate routes.

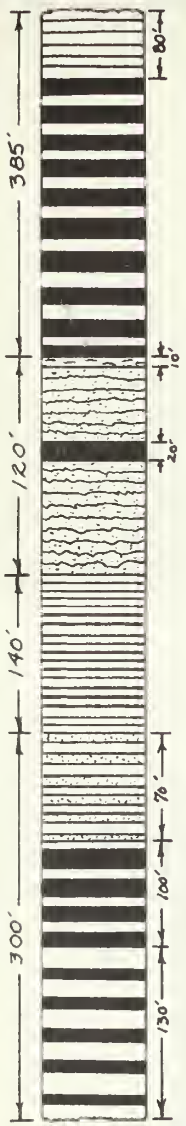
SOILS DATA

LOCATION					% PASSING		OPTIMUM	MAXIMUM	SOIL
(Station)	Line	L.L.	P.I.	-4M	-40M	-200M	MOISTURE	DENSITY	CLASS
588	A,B,C	27.6	3.6	100	90	42	17.8%	105.6	A4(1)
660	B,C	24.3	2.6	80	64	38	14.7	114.1	A4(1)
750	C	22.1	2.0	100	97	55	--	--	A4(4)
770	C	24.2	7.3	99	98	78	16.1	112.8	A4(8)
908	B	34.1	4.6	100	72	33	21.1	98.9	A2-4
							Remarks		
648	C	37.8	19.2	100	100	98	In PTW Ditch, 0-7.0' very soft clay, A6(12). 27.6% Moisture.		

COLUMBUS WEST

Generalized Cretaceous Sedimentary Rock Sequence

Average Thickness



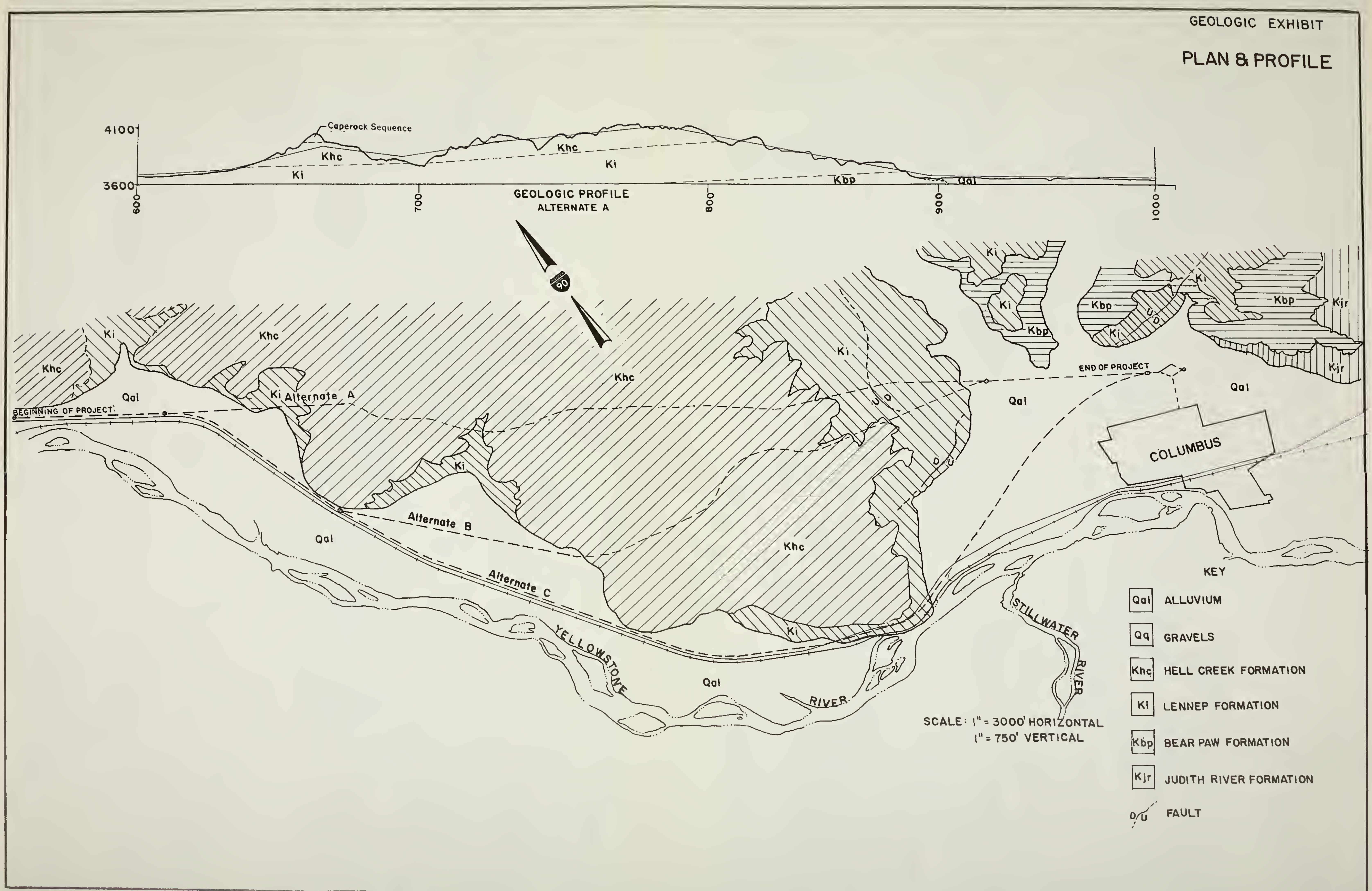
(top not found in area)

Thick sandstone with minor shale beds Alternating sandstone-shale	Hell Creek Formation	Alternating andesitic sandstone separated by beds of yellow, buff and dark green shales. Beds are competent when properly designed for back slope. Total thickness of the Hell Creek Formation is over 2000 ft.
Green shaly sandstone Alternating sandstone-shale Massive sandstone bed Alternating sandstone-shale	Lennep Formation	Formation thickness in area 120'(90'-160'). Dark sandstone with yellow, green, and grey shale. Limonite cement weathers light to very dark brown. Sandstone forms sharp escarpments between shale soil slopes. Beds are competent when cut slopes are properly designed.
Shale with minor sandstone beds	Bearpaw Shale Formation	Formation thickness in area 140'(120'-160'). Soft, grey, slightly sandy shale with interbedded lenses of thin sandstone beds. Backslopes require special design.
Predominately shale with thin sandstone beds. Alternating massive sandstone and shale beds Alternating sandstone and shale beds	Judith River Formation	Approximately 300' of Judith River Formations is exposed in the area east of Columbus. Grey to brown sandstone interbedded with yellow, green and black shales. Formation weathers buff to light brown. Shales weather readily from beneath competent sandstone, producing rock falls.

(bottom not found in area)

GEOLOGIC EXHIBIT

PLAN & PROFILE



ESTIMATING PROCEDURE

Grading Costs

Aerial photos of the study area were taken by the Montana Highway Commission to prepare contour maps. From these contour maps alternate routes were selected for study. Ground profiles and cross-sections were obtained from the contour maps, and grade lines were plotted on profile sheets. By entering grade data, backslope data, and typical sections in the IBM 1620 electronic computor, volumes of cut and fill for each route were computed and tabulated electronically.

Rock percentages in the major cuts were estimated from field studies conducted by the Montana Highway Commission geologists. Mass diagrams were plotted and used to estimate lengths of haul for each line. Blasting percentages and haul conditions were the primary factors affecting unit costs for earth quantities on each route.

Costs of clearing and grubbing, as well as watering and rolling costs, were estimated from average bid prices for similar jobs. Frontage road costs were estimated on state wide average per mile costs for the type of road.

Drainage

The costs of drainage structures 72" or less in diameter were based on average costs per mile. The costs of drainage pipes over 72" in diameter were estimated individually.

Base and Surfacing

Unit costs per mile for base and surfacing were estimated by correlating bid prices paid on a similar job to the typical section used in this study. Total costs for base and surfacing were in direct proportion to the length of each route.

Separations and Interchanges

Costs for separations and interchanges were estimated by adding separate costs for structure, grade and drain, base and surfacing, curbs and rails, and traffic control. Structural costs were estimated on average costs per square foot of deck area for the type of structure considered. Terrain features were considered in estimating costs for grading and drainage. Other items were estimated on the basis of average prices paid for similar installations built on the Interstate System in Montana.

Utility Adjustments

Each line was studied to determine utilities lying in the zones of construction. Utilities that needed to be moved were power, telephone, and telegraph poles. Costs for moving were figured on average unit costs per pole for each type of pole.

Miscellaneous

Miscellaneous costs were included for guardrail, fencing, and traffic control. Guardrail was included wherever fills existed that were greater than 10 feet in depth. Costs for fencing and traffic control were included at average current per mile bid prices.

Construction Costs

Tables 1, 2 and 3 give detailed breakdowns of total construction costs associated with Routes A, B and C, respectively. In table No. 4, the costs are separated into annual costs for each alternate route. Table No. 4 lists all major items of construction, the expected life of each item, and total and annual costs of each item. Annual construction costs were computed by amortizing total costs over the expected life of the item at a 6 percent interest rate. Subtotals of construction costs are tabulated to give comparisons of alternate routes excluding engineering and right-of-way costs. Totals including engineering and right-of-way costs are listed at the bottom of Table No. 4.

The table indicates the A Route to be the most expensive route in regard to construction costs. The annual construction cost of the A Route is $295,353, which is $72,429, or 32% more than that of the B Route and $65,017, or 28% more than that of the C Route.

In examining items of construction, it can be seen that the major difference in construction costs between alternate routes lies in grading costs. A large earth quantity having a high blasting percentage accounts for the expensive grading cost associated with the A Route.

Although the A Route entails considerably more expense for grading than do the B or C Routes, the A Route has savings over the B and C Routes in utility adjustments, base and surfacing, and right-of-way costs.

The A Route involves very few utility adjustments since the bulk of its length is through undeveloped country. On the other hand, the C Route closely parallels the present highway and interferes with power and telephone lines in a number of places. In addition, a large utility item was includes on the C Route for construction of flumes in the vicinity of Benson's Bluff. Annual costs for utility adjustments on the A Route are $2,832 less than on the B Route and $11,686 less than on the C Route.

The A Route's short length makes its cost for base and surfacing least expensive. Annual costs for base and surfacing on the A Route is $4,358 less than on the B Route and $10,170 less than on the C Route.

Miscellaneous costs on the A Route are the greatest because the A Route has a greater number of embankments requiring guardrail than do the B or C Routes.

To summarize, it may be said that the A Route would involve the greatest total cost for construction. The high cost for earthwork on the A Route is offset somewhat by A Route savings in utility adjustments, base and surfacing, and right-of-way costs. Before reaching a conclusion as to the most feasible route, one must include the effect of costs incurred in maintenance of each route and costs paid by motor vehicle operators using each route.

TABLE NO. 1

ESTIMATED CONSTRUCTION COST

LINE A

ITEM	UNIT	UNIT COST	QUANTITY	SUBTOTAL	TOTAL
Utility Adjustments	Lump Sum	$		$	$ 3,113
Grade and Drain					2,147,651
Grading	Cu. Yd.	0.644	3,191,898	2,055,582	
Minor Drainage	Mile	11,700	7.635	89,330	
Frontage Roads	Mile	8,300	0.33	2,739	
Base and Surfacing					701,820
Base	Mile	47,772	7.635	364,739	
Plant Mix	Mile	43,770	7.635	334,184	
Frontage Roads	Mile	8,780	0.33	2,897	
Grade Separations	Lump Sum				126,426
Interchanges					223,373
Structure	Sq. Ft.	10.20	7,700	78,540	
Grading	Cu. Yd.	0.45	147,900	66,555	
Drainage	Lump Sum	--	--	1,000	
Base and Surfacing	Lump Sum	--	--	56,183	
Curbs and Guardrails	Lump Sum	--	--	6,095	
Traffic Control	Lump Sum	--	--	15,000	
Miscellaneous					179,445
Guardrail	Mile	13,728	8.522	116,990	
Fencing	Mile	7,680	7.635	58,637	
Traffic Control	Mile	500	7.635	3,818	
Construction Items					3,381,828
Engineering & Contingencies	15%				507,274
Right of Way	Lump Sum				276,243
TOTAL					$4,165,345

TABLE NO. 2

ESTIMATED CONSTRUCTION COST

LINE B

ITEM	UNIT	UNIT COST	QUANTITY	SUBTOTAL	TOTAL
Utility Adjustments	Lump Sum	$		$	$ 45,706
Grade and Drain					1,062,752
Grading	Cu. Yd.	0.575	1,670,034	960,270	
Minor Drainage	Mile	11,700	8.181	95,718	
Channel Change	Cu. Yd.	.575	7,000	4,025	
Frontage Roads	Mile	8,300	0.33	2,739	
Base and Surfacing					751,801
Base	Mile	47,772	8.181	390,822	
Plant Mix	Mile	43,770	8.181	358,082	
Frontage Roads	Mile	8,780	0.33	2,897	
Grade Separations	Lump Sum				126,426
Interchanges					223,373
Structure	Sq. Ft.	10.20	7,700	78,540	
Grading	Cu. Yd.	0.45	147,900	66,555	
Drainage	Lump Sum	--	--	1,000	
Base and Surfacing	Lump Sum	--	--	56,183	
Curbs and Guardrails	Lump Sum	--	--	6,095	
Traffic Control	Lump Sum	--	--	15,000	
Miscellaneous					175,069
Guardrail	Mile	13,728	7.878	108,149	
Fencing	Mile	7,680	8.181	62,830	
Traffic Control	Mile	500	8.181	4,090	
Construction Items					2,385,127
Engineering and Contingencies	15%				357,769
Right of Way	Lump Sum				321,210
TOTAL					$3,064,106

TABLE NO. 3

ESTIMATED CONSTRUCTION COST

LINE C

ITEM	UNIT	UNIT COST	QUANTITY	SUBTOTAL	TOTAL
Utility Adjustments	Lump Sum	$		$	$ 178,849
Grade and Drain					861,213
Grading	Cu. Yd.	0.530	1,386,700	734,951	
Minor Drainage	Mile	11,700	8.701	101,802	
Channel Change	Cu. Yd.	0.530	7,000	3,710	
Frontage Roads	Mile	8,300	2.50	20,750	
Base and Surfacing					818,457
Base	Mile	47,772	8.701	415,664	
Plant Mix	Mile	43,770	8.701	380,843	
Frontage Roads	Mile	8,780	2.50	21,950	
Grade Separations	Lump Sum				252,852
Interchanges					223,373
Structures	Sq. Ft.	10.20	7,700	78,540	
Grading	Cu. Yd.	0.45	147,900	66,555	
Drainage	Lump Sum	--	--	1,000	
Base and Surfacing	Lump Sum	--	--	56,183	
Curbs and Guardrails	Lump Sum	--	--	6,095	
Traffic Control	Lump Sum	--	--	15,000	
Miscellaneous					100,826
Guardrail	Mile	13,728	2.160	29,652	
Fencing	Mile	7,680	8.701	66,824	
Traffic Control	Mile	500	8.701	4,350	
Construction Items					2,435,570
Engineering & Contingencies	15%				365,336
Right of Way	Lump Sum				405,828
TOTAL					$3,206,734

TABLE NO. 4

ANNUAL CONSTRUCTION COST

ITEM	LIFE	LINE		LINE		LINE	
		TOTAL	ANNUAL	TOTAL	ANNUAL	TOTAL	ANNUAL
Utility Adjustments	40	$ 3,113	$ 207	$ 45,706	$ 3,039	$ 178,849	$ 11,893
Grade and Drain	40	2,147,651	142,819	1,062,752	70,673	861,213	57,271
Base and Surfacing	20	701,820	61,199	751,801	65,557	818,457	71,369
Grade Separations	50	126,426	8,015	126,426	8,015	252,852	16,031
Interchanges	30	223,373	16,217	223,373	16,217	223,373	16,217
Miscellaneous	20	179,445	15,648	175,069	15,266	100,826	8,792
Engineering & Contingencies	40	507,274	33,734	357,769	23,792	365,336	24,295
Right of Way	50	276,243	17,514	321,210	20,365	405,828	25,729
TOTAL		$4,165,345	$295,353	$3,064,106	$222,924	$3,206,734	$231,597

TABLE NO. 5

ANNUAL MAINTENANCE COSTS

ROADWAY	COST PER MILE	LINE A		LINE B		LINE C	
		MILES	COST	MILES	COST	MILES	COST
INTERSTATE	$ 3,000	7.64	$22,920	8.18	$24,540	8.70	$26,100
EXTRA SANDING *	500	4.08	2,040	2.74	1,370	---	---
FRONTAGE ROADS	1,500	0.33	495	0.33	495	2.50	3,750
TOTAL			$25,455		$26,405		$29,850

* Extra sanding on steep Interstate grades.

MAINTENANCE COSTS

Table No. 5 shows annual maintenance costs that were estimated for each route.

Maintenance costs for 4-lane Interstate Highway were calculated at $3,000/mile. An extra annual cost of $500/mile was included for sanding and snow removal on Interstate sections involving higher elevations and steeper grades.

Maintenance costs for frontage roads were included at annual costs of $1,500/mile for frontage roads.

The table indicates that annual maintenance costs on the A Route would be lower than on either the B or C Routes. Maintenance costs on the A Route are $950/year less than on the B Route and $4,395/year less than on the C Route.

OPERATOR'S COSTS

Operator's costs, commonly referred to as road user costs, are all costs associated with owning and operating a motor vehicle. Road user costs include costs for investment, time, fuel, oil, and all maintenance items; and are calculated in terms of unit costs per vehicle-mile of travel. These unit costs depend upon the type of vehicle considered, and upon road features such as curvature, percent grades, and conditions of road surfaces. Travel speeds also bear a relationship to vehicle operating costs.

In making a route study a comparison must be made between total road user costs that will be associated with each route. In computing road user costs, one must consider operating costs for traffic using any road that will be affected by an alternate route.

Costs for operating vehicles on roads in the Columbus vicinity were calculated separately for cars and trucks, and separate unit costs were used for each class or road.

For vehicles using the Interstate Highway, unit costs were further divided by separating unit costs on the basis of per cent of grade. The following table shows per mile costs used in computing road user costs for this report.

ROAD CLASSIFICATION	COST PER VEHICLE MILE	
	CARS	TRUCKS
Four-Lane Interstate	$0.0977(0-3%) 0.1015 (3-5%)	$0.2778 (0-1%) 0.2791 (2%) 0.3066 (3%) 0.3464 (4%) 0.3966 (5%)
Primary (Rural)	0.1105	0.3473
Secondary (Rural)	0.1140	0.3583
County (Rural)	0.1289	0.3867
City Streets (Urban)	0.1409	0.4428

In computing road user costs, it is necessary to know the average daily traffic volumes that will pertain to each road affected by an alternate route. Traffic counts as well as origin and destination data were taken at Columbus by the Planning Survey Department of the Montana Highway Commission. From this data, it was possible to estimate average car and truck traffic volumes that could be expected on each road over a 20-year study period. Average annual vehicle-miles of travel on each road were computed by multiplying travel distances by annual traffic volumes. By applying appropriate car and truck unit costs to annual vehicle-miles of traffic, total annual costs on each road affected were computed. Table No. 6 is a comparison of annual operating costs for Columbus-West Routes A, B, and C.

The table indicates that annual operating costs are lowest for the A Route. Low operating costs for the A Route can be attributed primarily to low Interstate roaduser costs resulting from a shortened travel distance. The table shows that annual roaduser costs on the A Route are $73,130 less than on the B Route and $96,468 less than on the C Route.

In general, the A Route gives superior service to local Columbus traffic as well as to through Interstate traffic.

TABLE NO. 6

ANNUAL OPERATING COSTS

FACILITY	LENGTH	AVERAGE DAILY TRAFFIC	ANNUAL VEHICLE MILES	COST PER MILE	ANNUAL OPERATING COST
LINE A					
Interstate	7.635	3078	8,577,693	$ .1357	$1,163,993
Local	7.954	40	116,128	.1460	16,955
Total					1,180,948
LINE B					
Interstate	8.181	3078	9,191,108	.1346	1,237,123
Local	7.954	40	116,128	.1460	16,955
Total					1,254,078
LINE C					
Interstate	8.701	3078	9,775,312	.1289	1,260,038
Local	3.220	40	47,012	.1248	5,867
Local	5.400	40	78,840	.1460	11,511
Total					1,277,416

As noted previously, the most favorable alternate based on monetary considerations is the alignment which has the lowest overall construction, maintenance, and operating costs. Table No. 7 shows that Line A has total annual cost of $2,000 less than Line B, and $38,000 less than Line C.

TABLE NO. 7

TOTAL ANNUAL COST

ITEM	COST ($1,000)		
	LINE A	LINE B	LINE C
CONSTRUCTION	$ 295	$ 223	$ 232
MAINTENANCE	25	26	30
OPERATING	1,181	1,254	1,277
TOTAL	$ 1,501	$ 1,503	$ 1,539

In addition to the factors which have been previously discussed, several others which are more difficult to represent in monetary terms have been considered.

Line A, because it is constructed almost entirely through uncultivated land and with a minimum of interference to the irrigated lands, would cause considerably less disruption to the agricultural development of the area. This is best illustrated by the Irrigation and Drainage Exhibit.

Line C, because it parallels the present highway for almost its entire length, causes more disruption to the present traffic pattern through the valley area west of Columbus. In addition to affecting private vehicular travel, it will lengthen existing school bus and mail routes. Considerable concern was expressed at the Columbus public hearing regarding this matter.

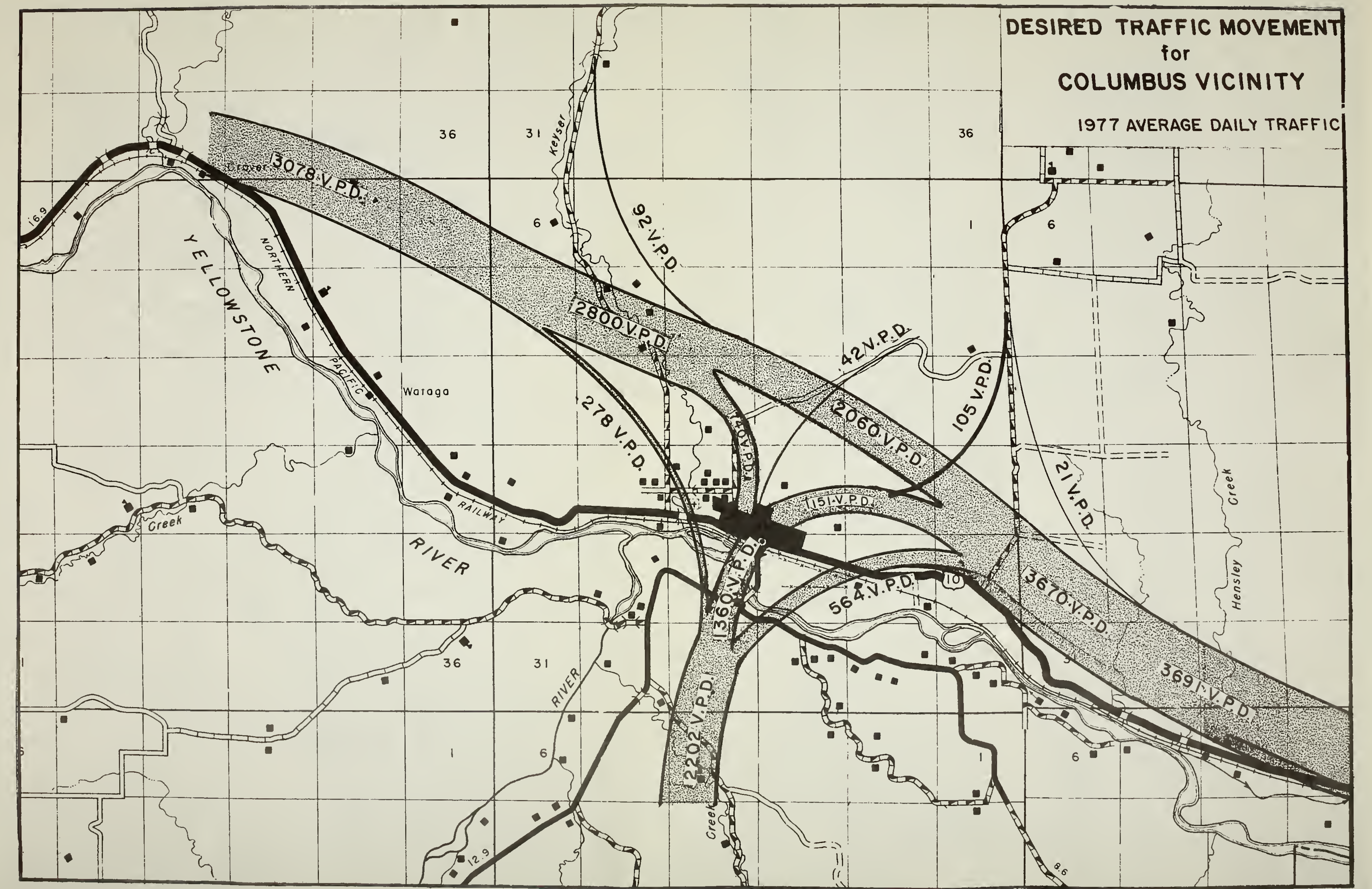
All three alternates provide essentially the same access routes into Columbus and should, therefore, have approximately the same effect on the highway-oriented businesses in the Community. There may, however, be some advantage to Line A and Line B, in that they will provide excellent views of the Town to eastbound travelers, which may entice the would-be through-travelers into Columbus.

No monetary value has been placed on the convenience to the traveler and the contractor in not having to maintain traffic through the construction zone of Line C.

At the public hearing held in Columbus on October 6, 1964, Line A was favored by approximately 60% of those present and no serious objection was voiced against it.

RECOMMENDATION

An analysis of all major routing criteria indicates that Alternate A is the best alignment for Interstate 90 in this area. Route A, which is recommended, was favored at the public hearing, however, no serious objection was voiced of Alternate B, which costs $1,000,000 less initially, and thus is worthy of serious consideration.



DESIRED TRAFFIC MOVEMENT for COLUMBUS VICINITY

1977 AVERAGE DAILY TRAFFIC

LEGEND

EXISTING FEATURES

PAVED ROAD

TRAIL

BRIDGE

STREAM

INTERMITTENT STREAM

IRRIGATION DITCH

DEPRESSION

RAILROAD

RAILROAD OVERPASS

SPOT ELEVATION

BUILDINGS

UTILITY POLE

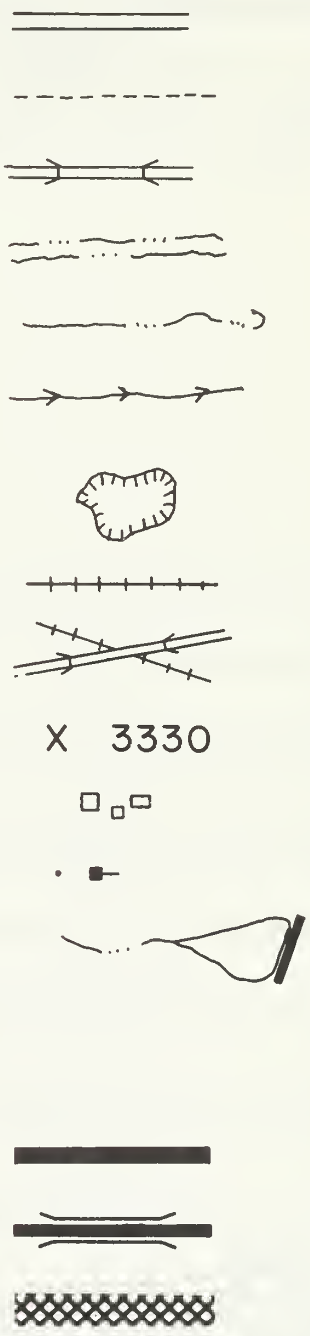
RESERVOIR & DAM

PROPOSED FEATURES

INTERSTATE HIGHWAY

INTERSTATE BRIDGE

CHANNEL CHANGE



ALTERNATE A
COLUMBUS —WEST

PLAN & PROFILE

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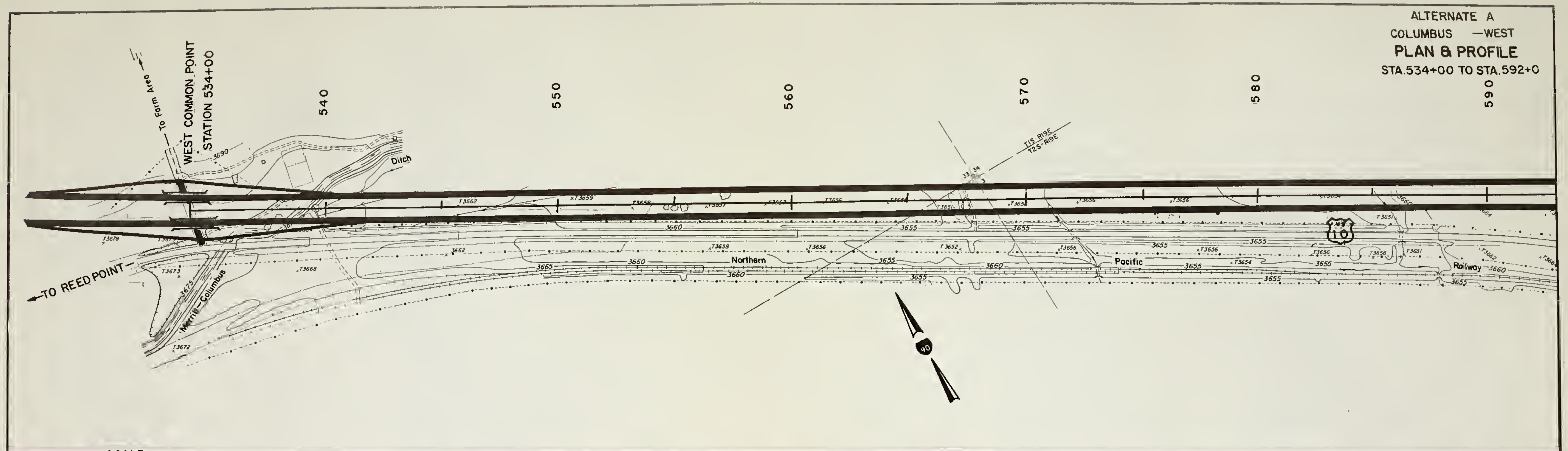

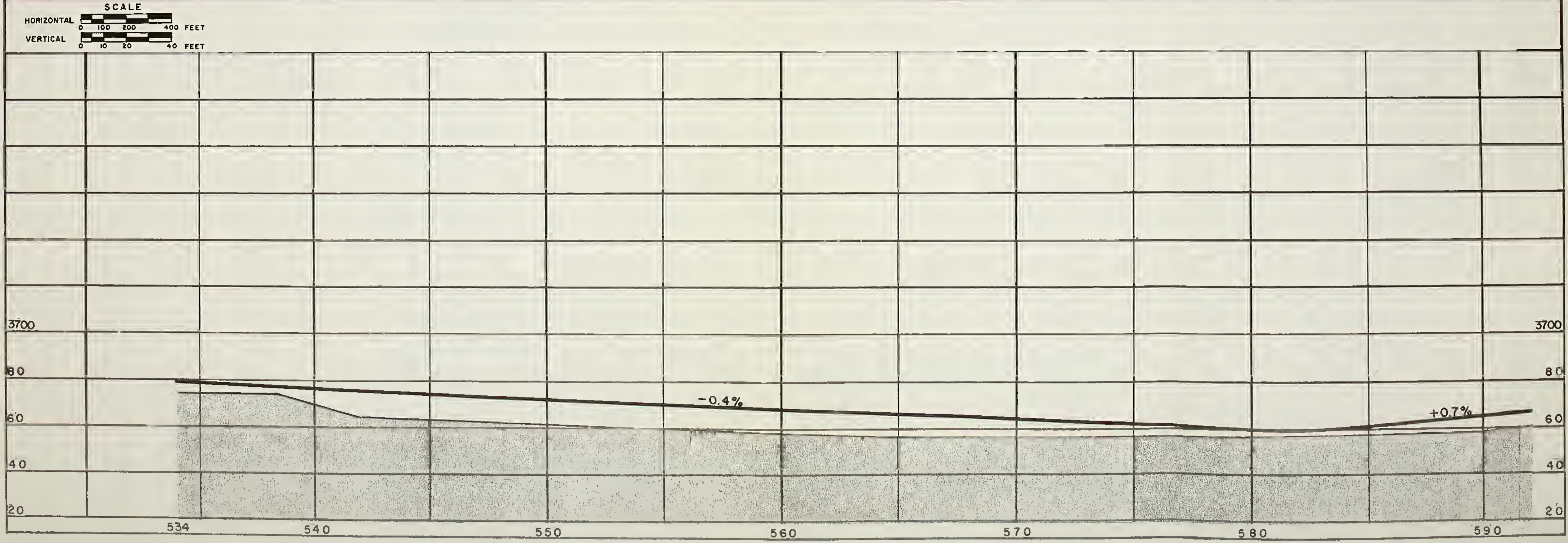

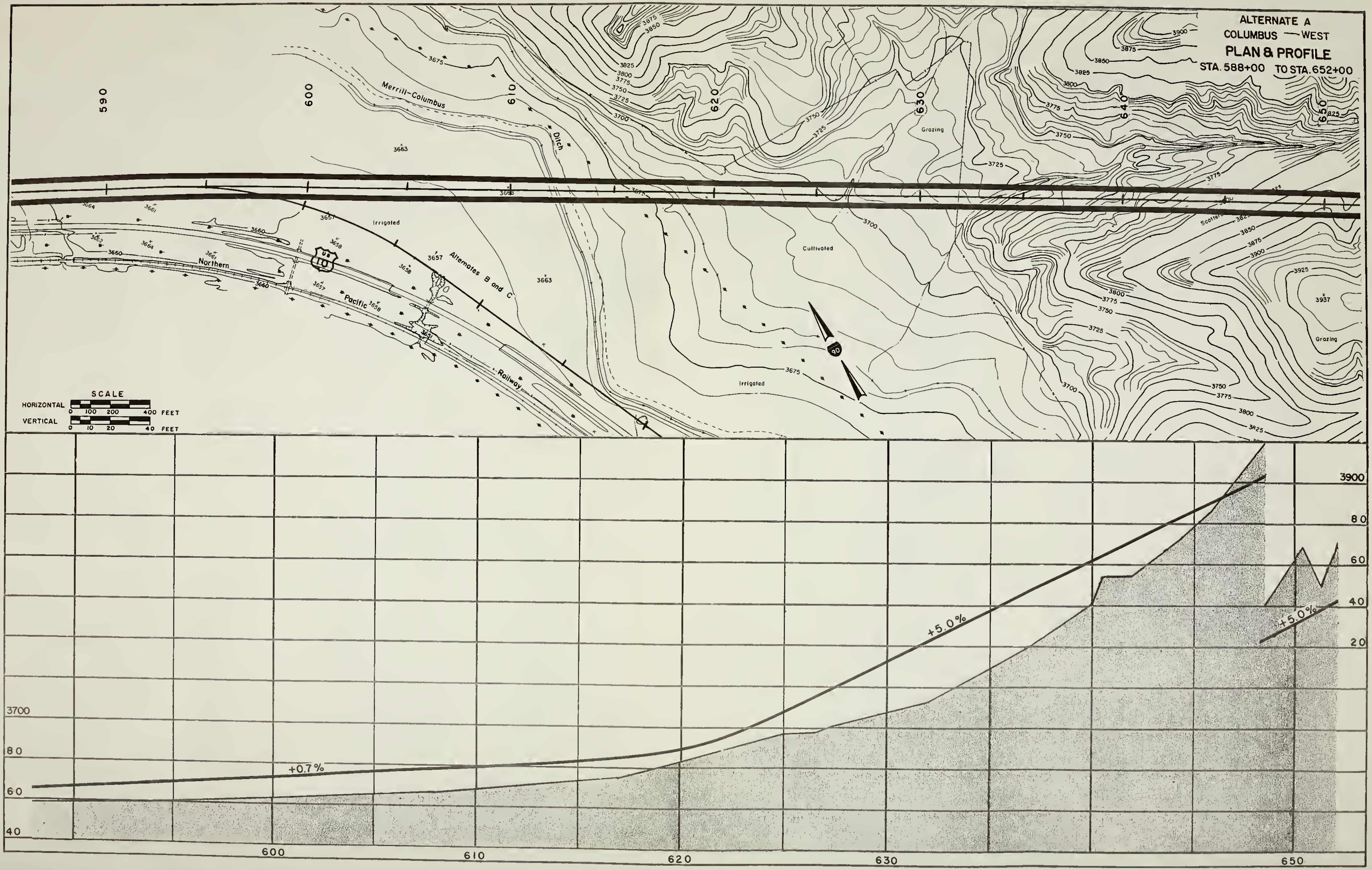
ALTERNATE A
COLUMBUS — WEST
PLAN & PROFILE
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590
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610
620
630
640
650
Merrill-Columbus
Ditch
Irrigated
Cultivated
Grazing
Alternates B and C
Northern
Pacific
Railway
US 10
90
Scotters
3663
3657
3658
3660
3661
3664
3662
3651
3937
3675
3700
3725
3750
3775
3800
3825
3850
3875
3900
3925
SCALE
HORIZONTAL
0 100 200 400 FEET
VERTICAL
0 10 20 40 FEET
+0.7%
+5.0%
+5.0%
3900
80
60
40
20
3700
80
60
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600
610
620
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ALTERNATE A
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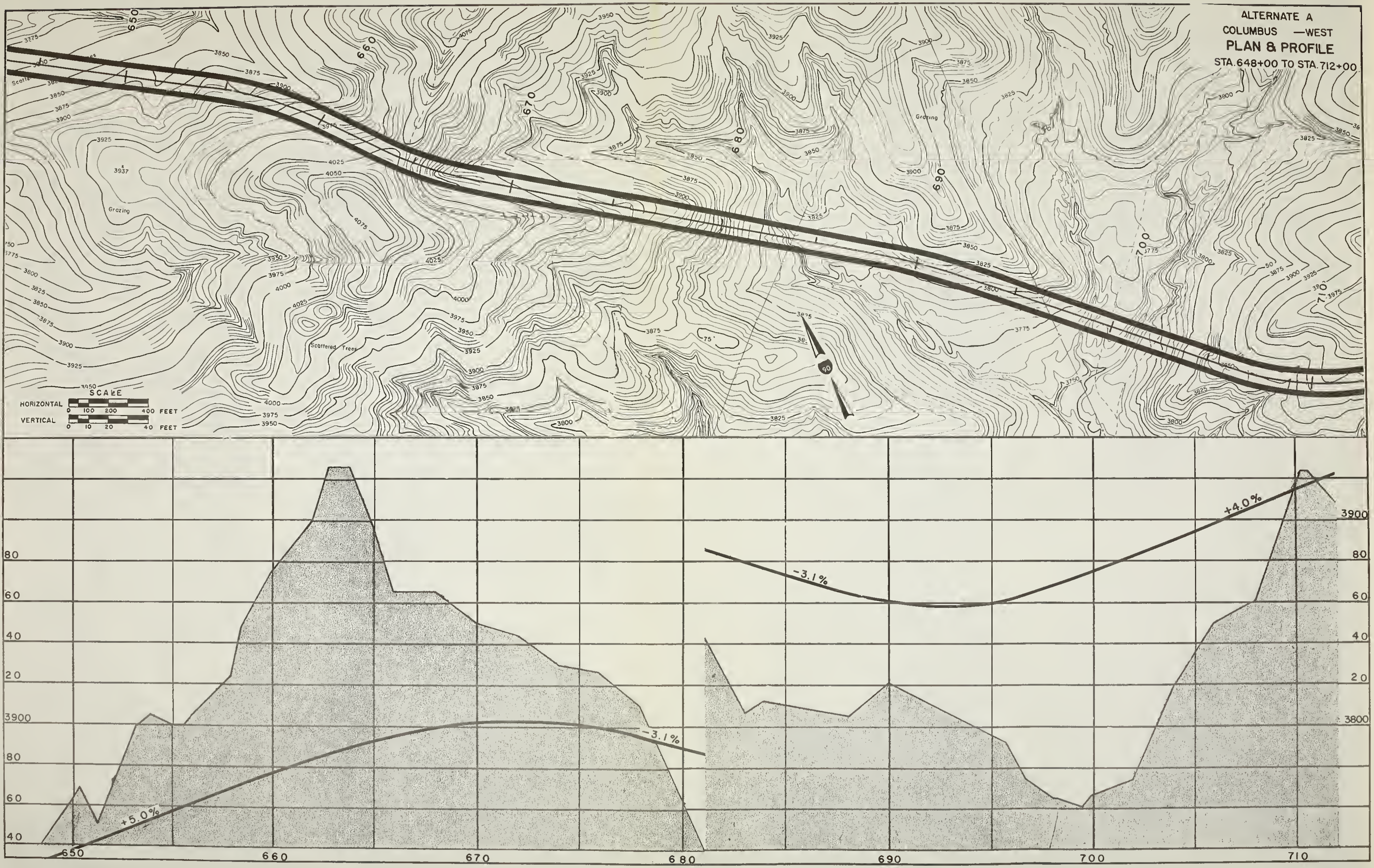

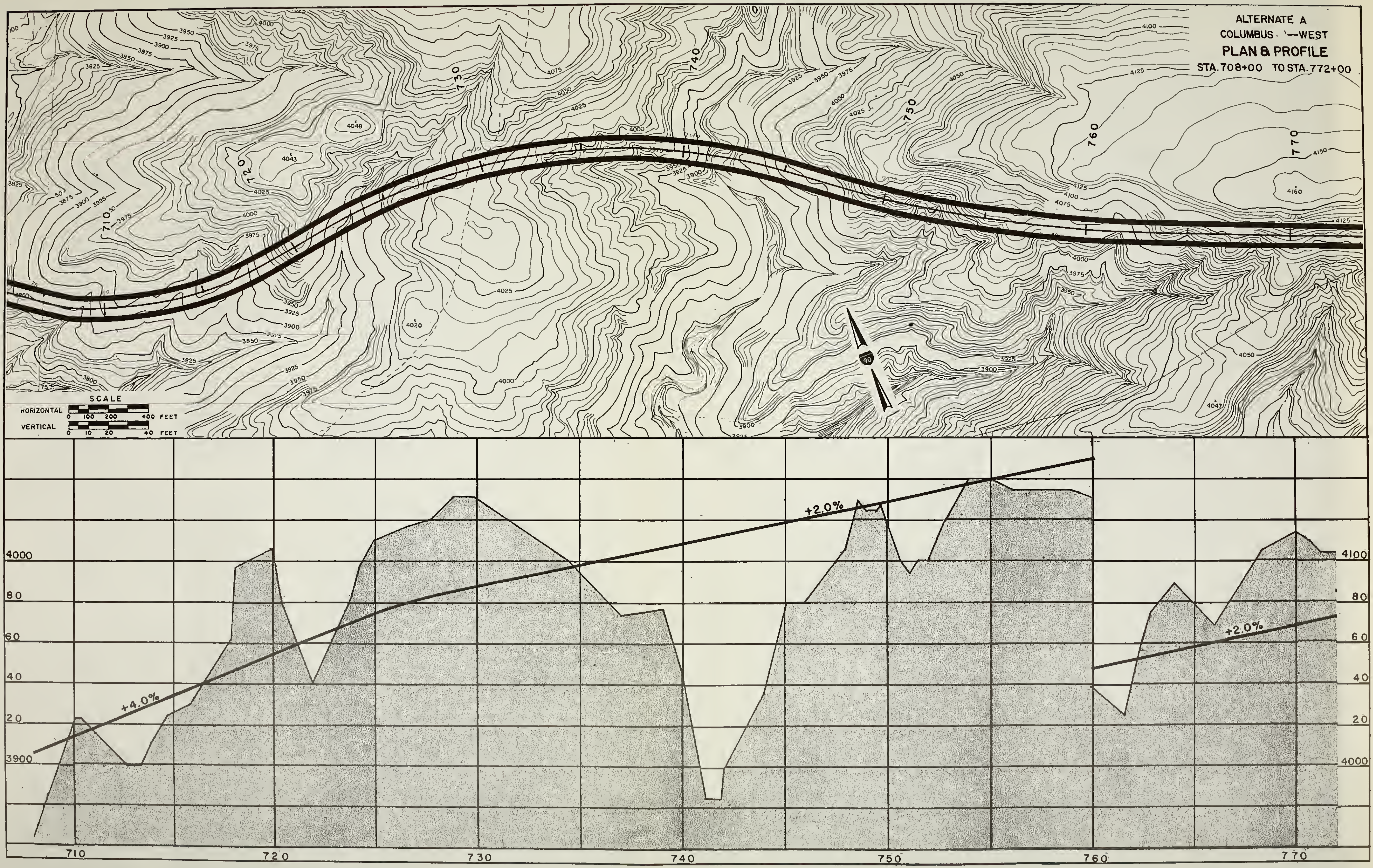

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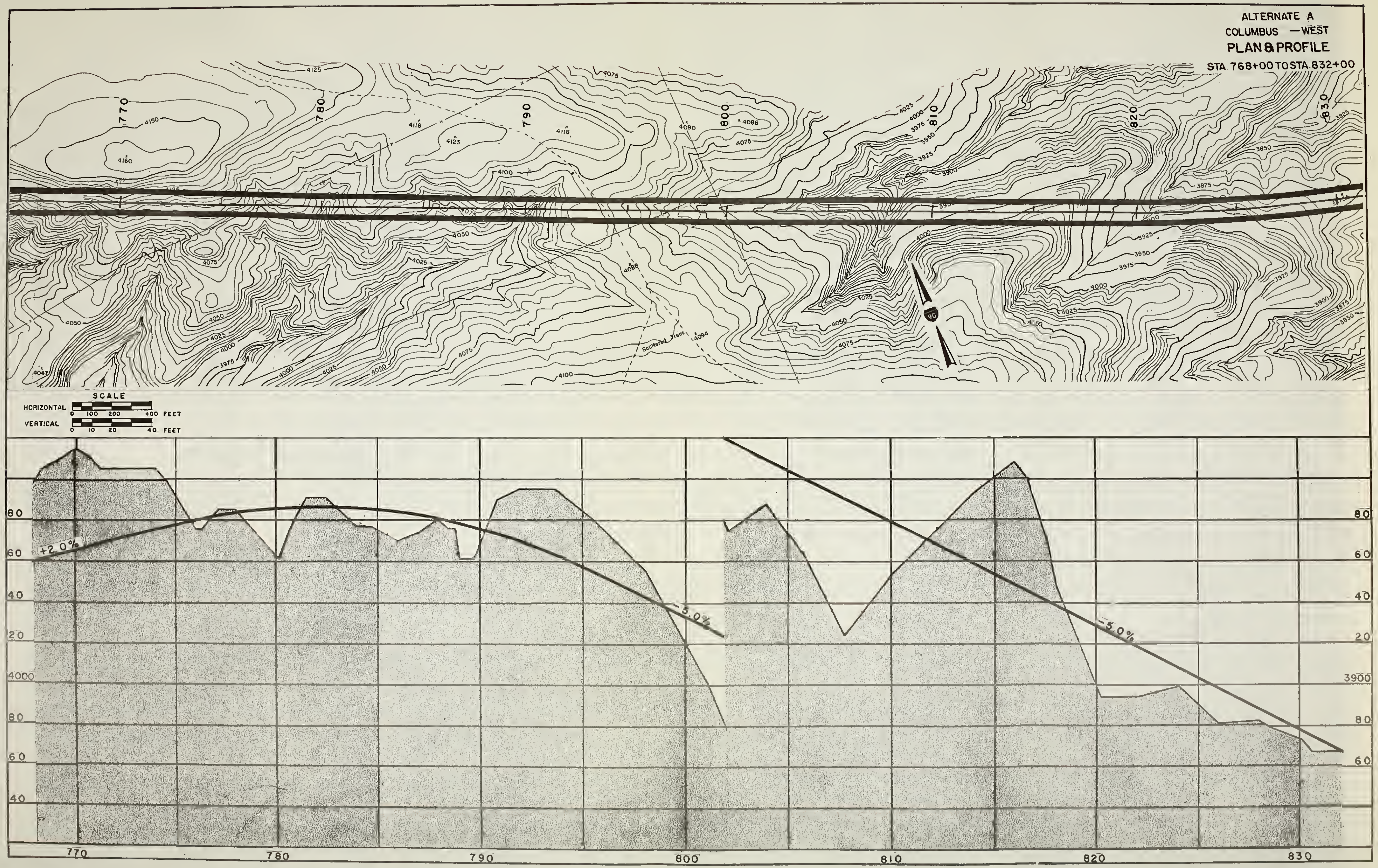

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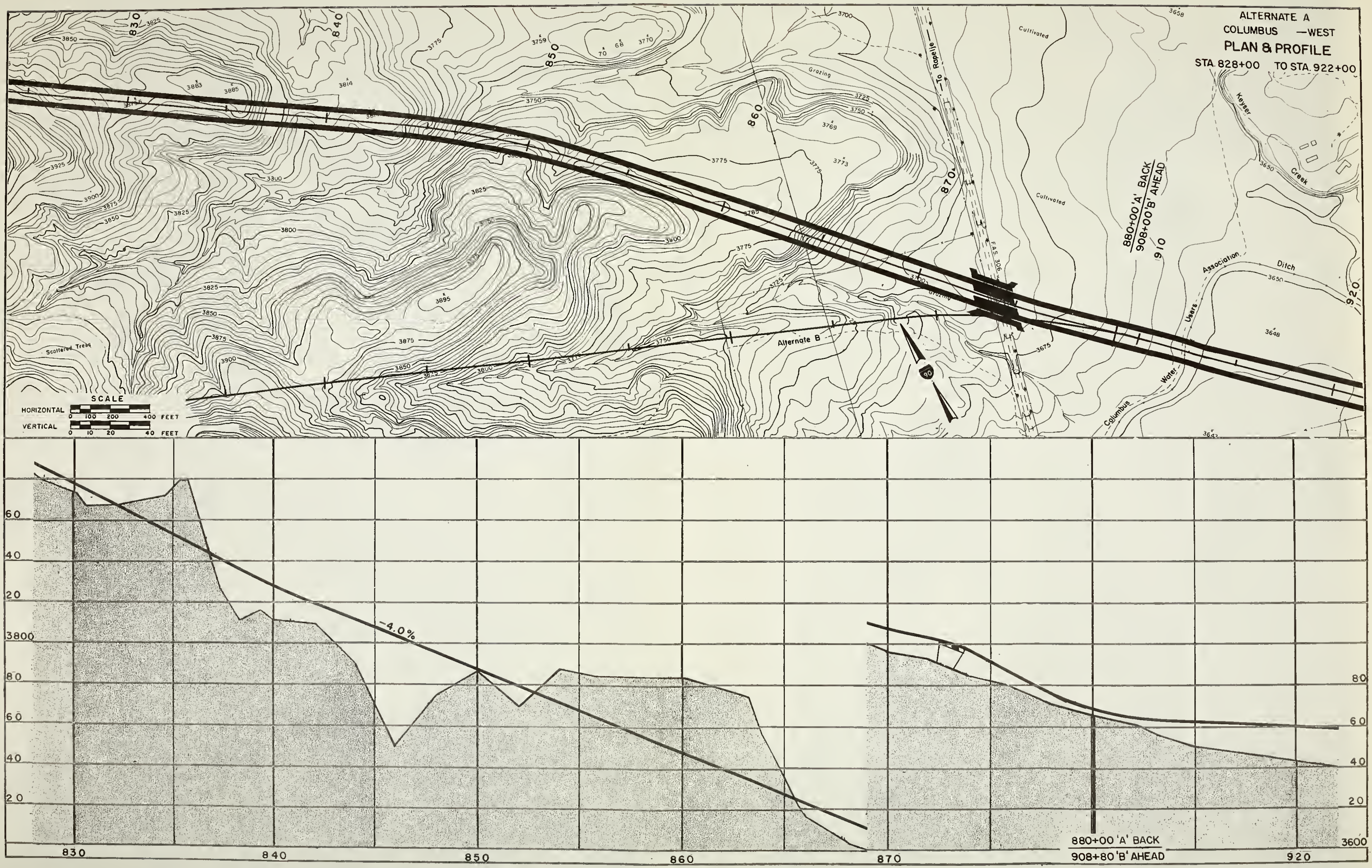

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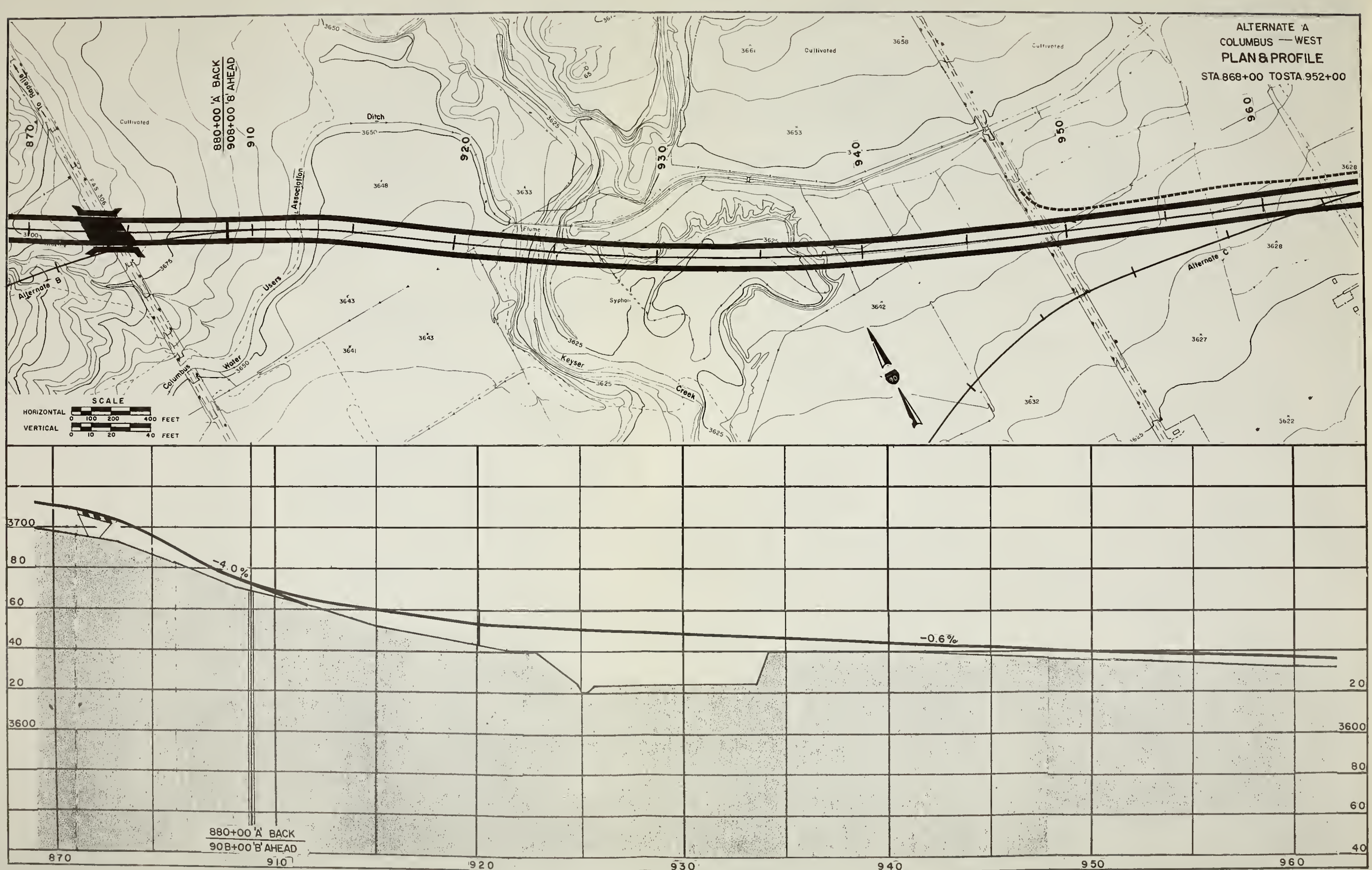
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PLAN & PROFILE
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ALTERNATE A
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PLAN & PROFILE
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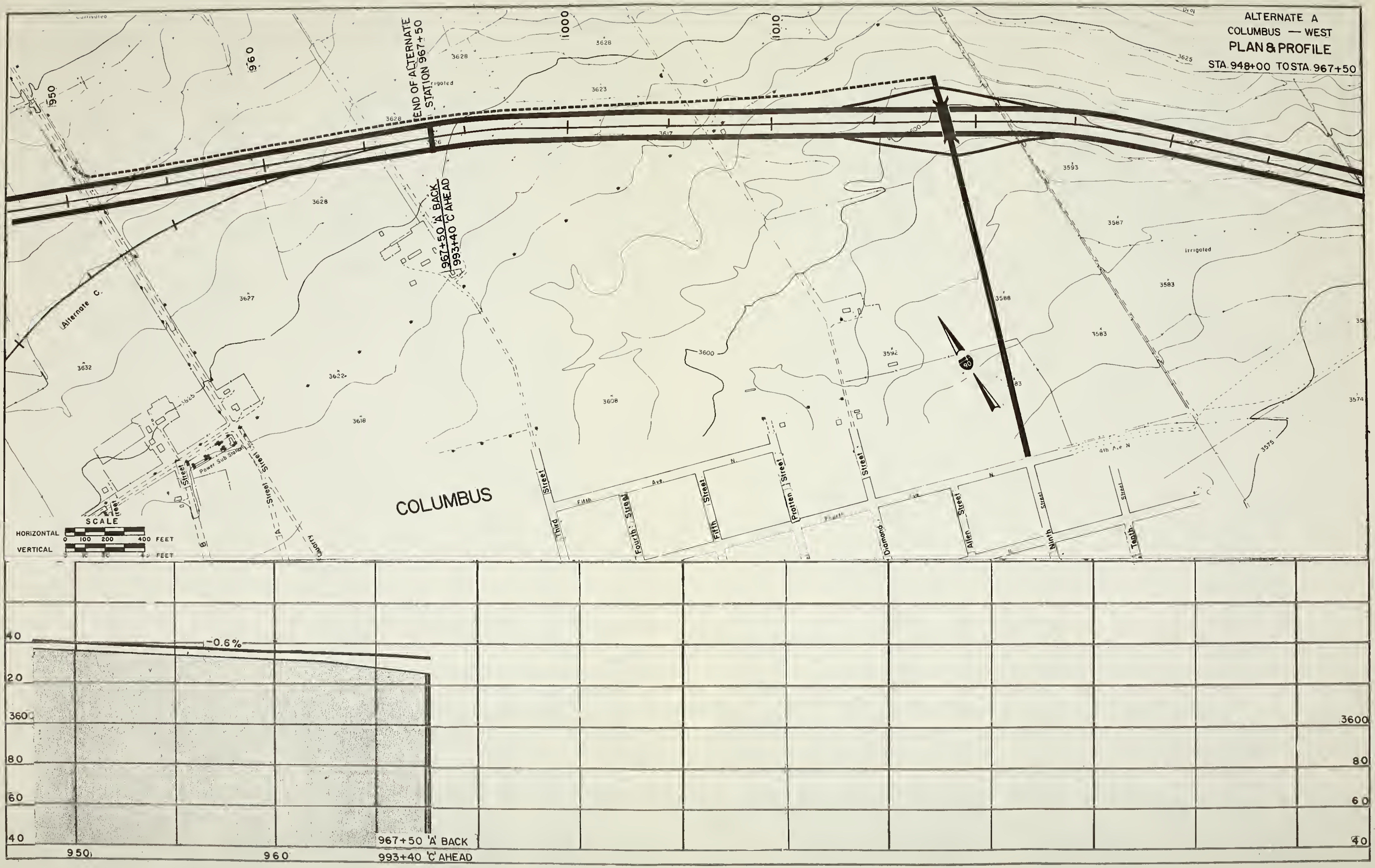

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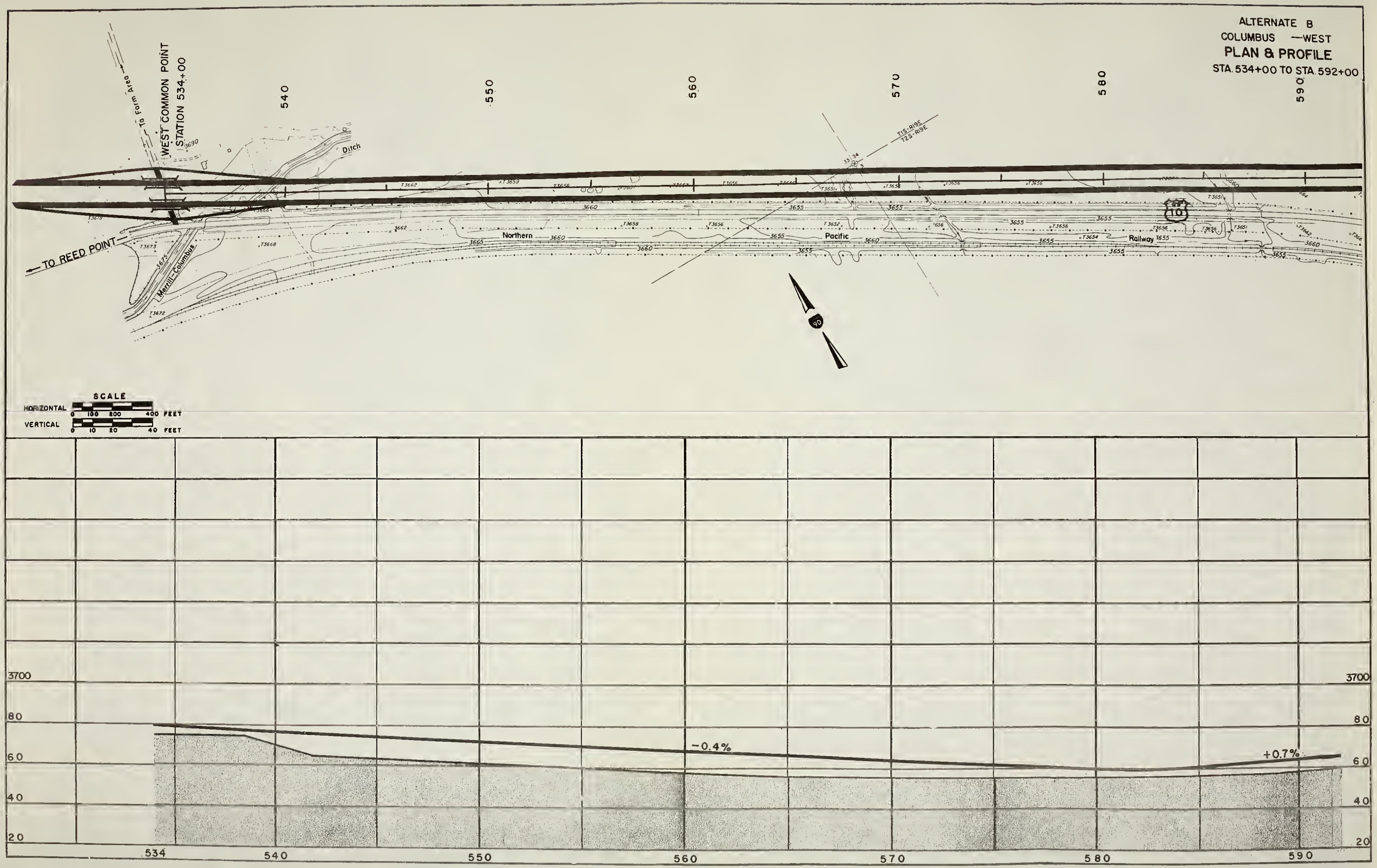

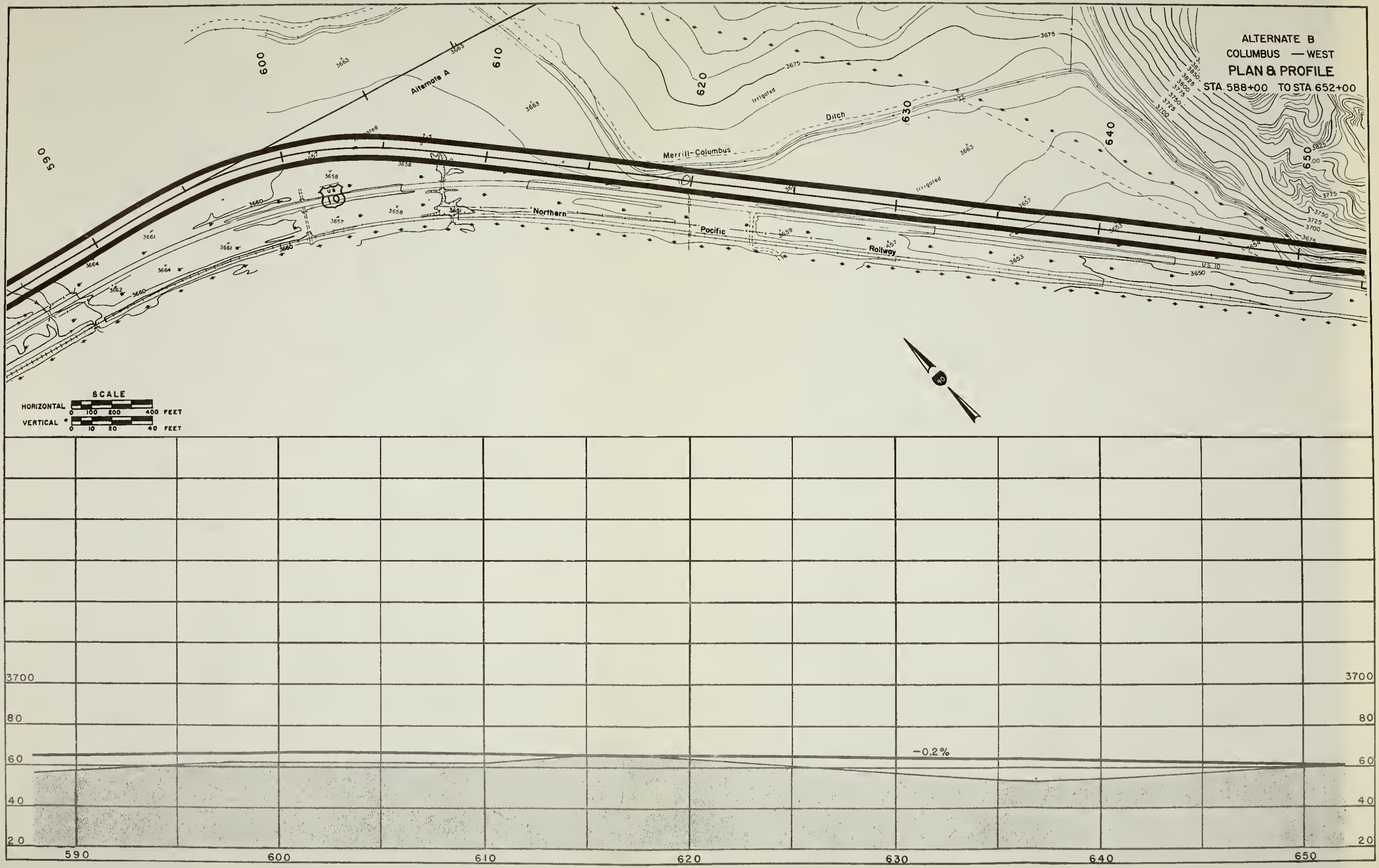

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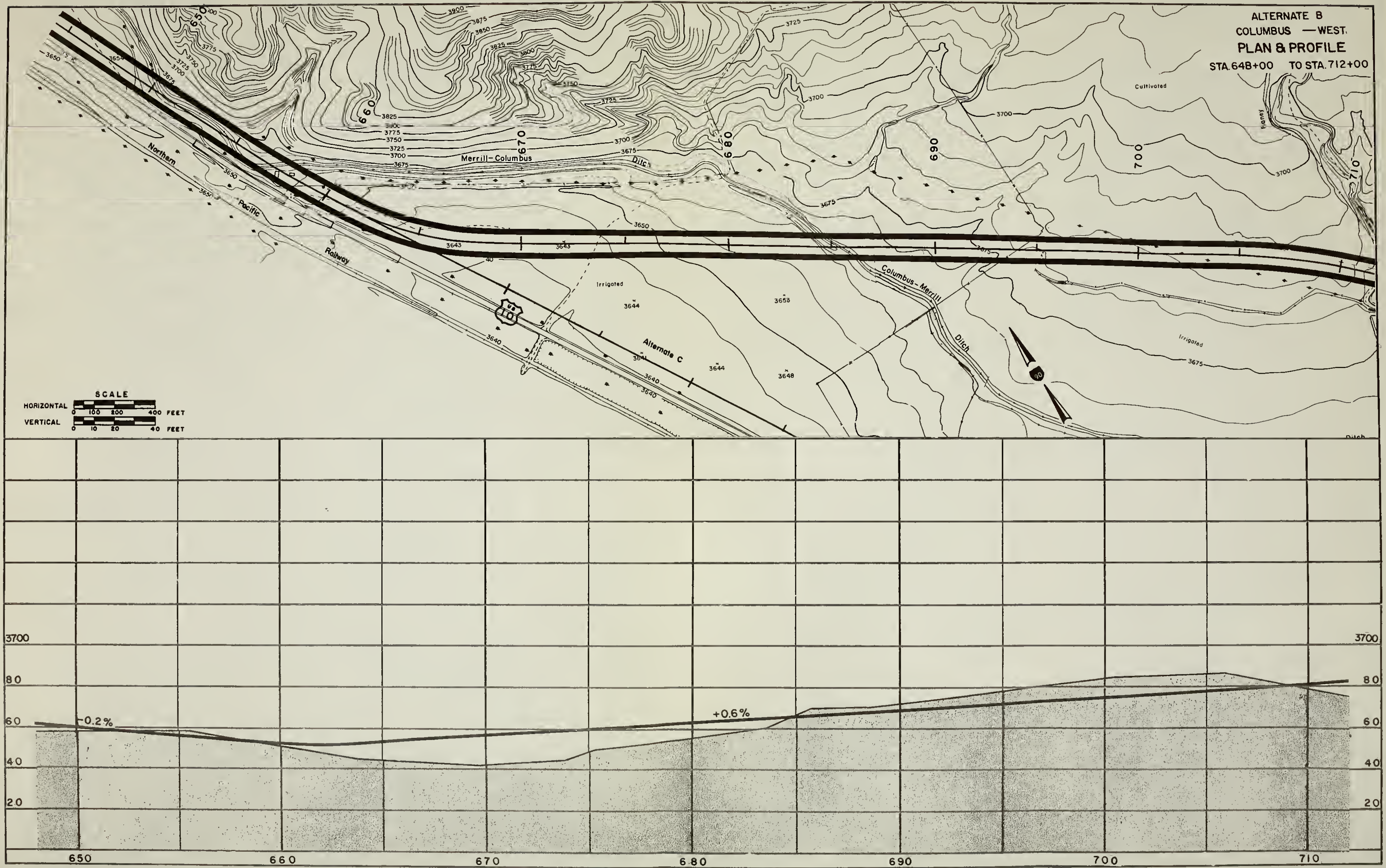

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PLAN & PROFILE
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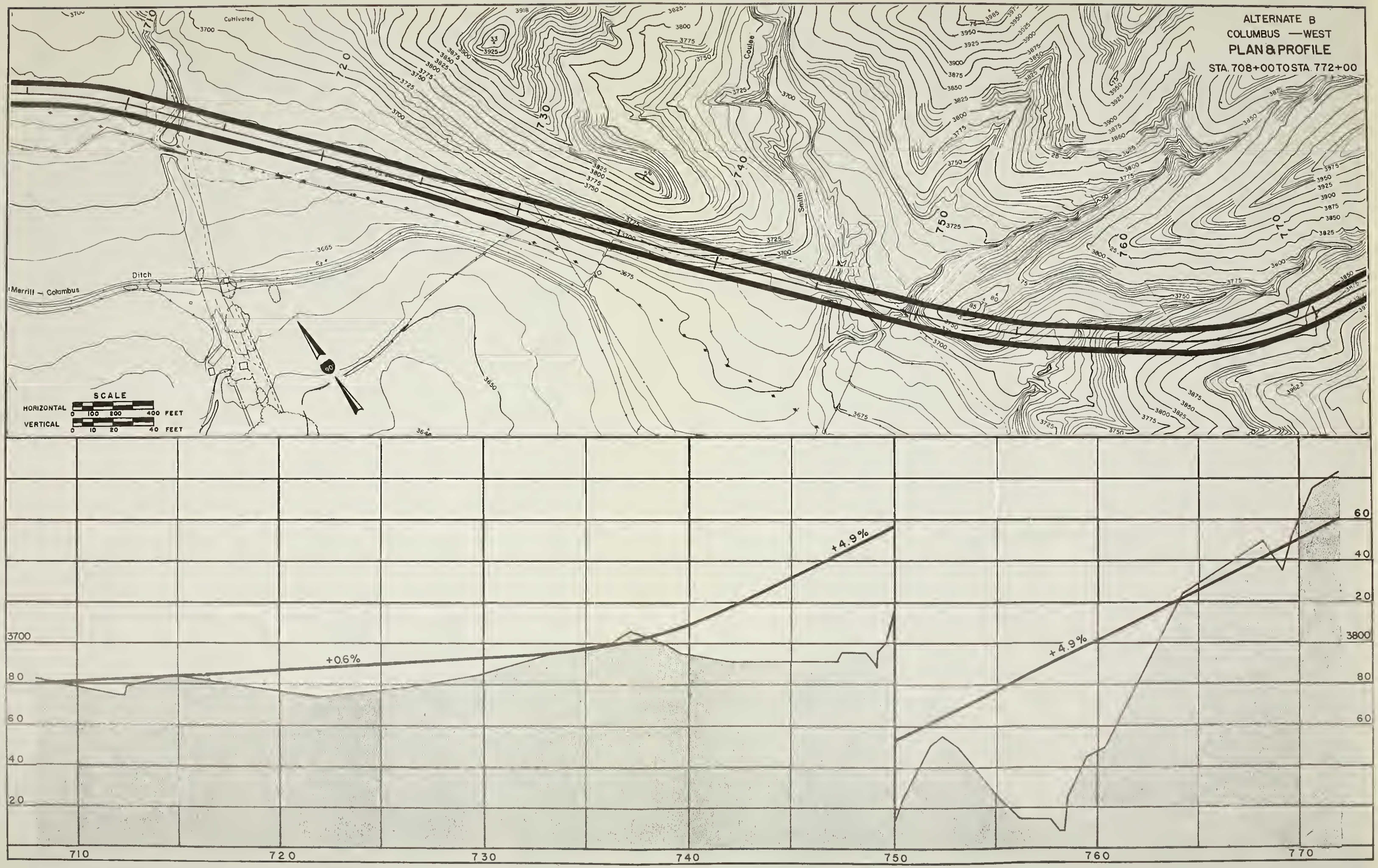

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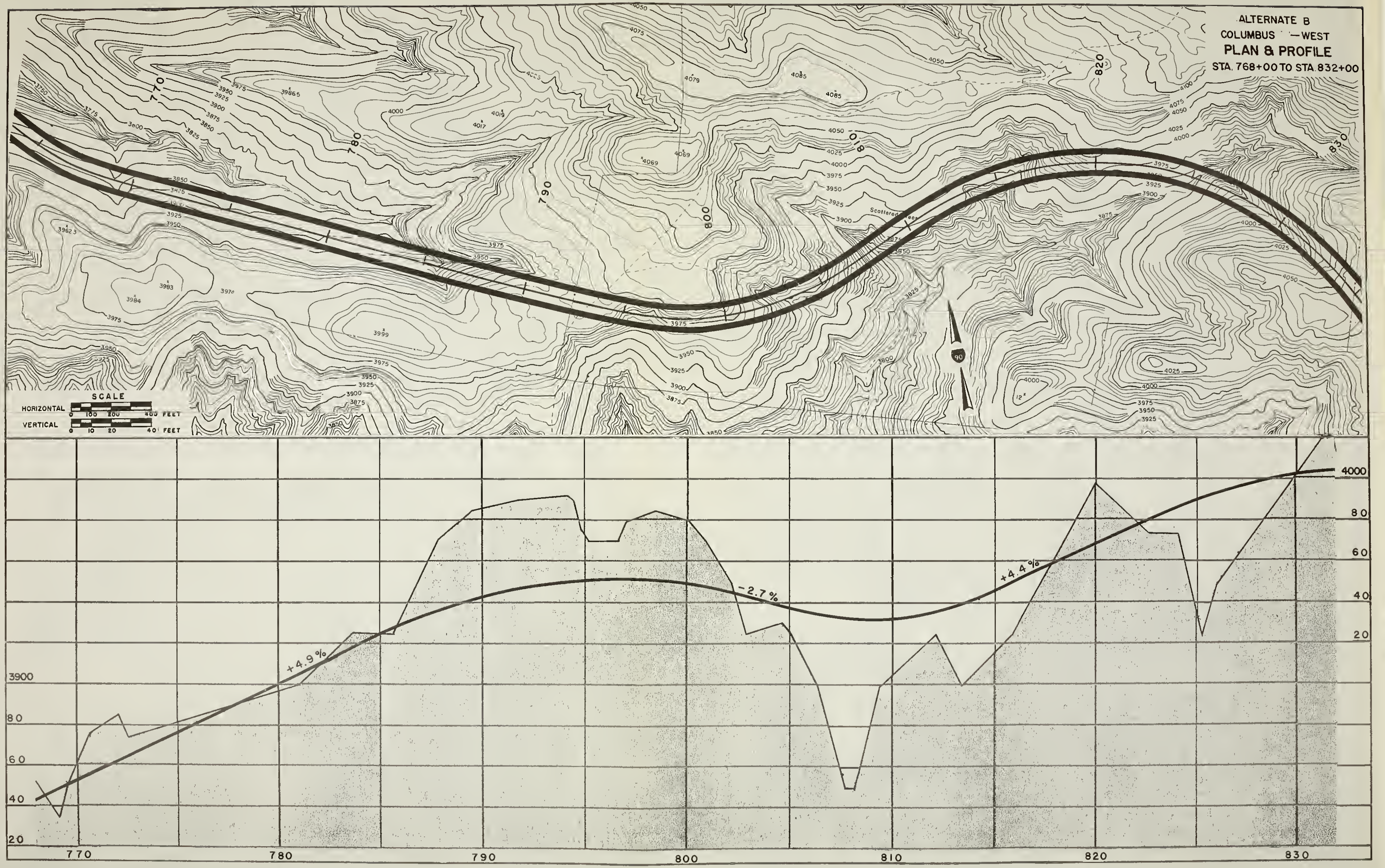
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COLUMBUS —WEST
PLAN & PROFILE
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VERTICAL 0 10 20 40 FEET
770
780
790
800
810
820
830
90
Scattered Trees
3750
3775
3800
3825
3850
3875
3900
3925
3950
3975
4000
4025
4050
4075
4100
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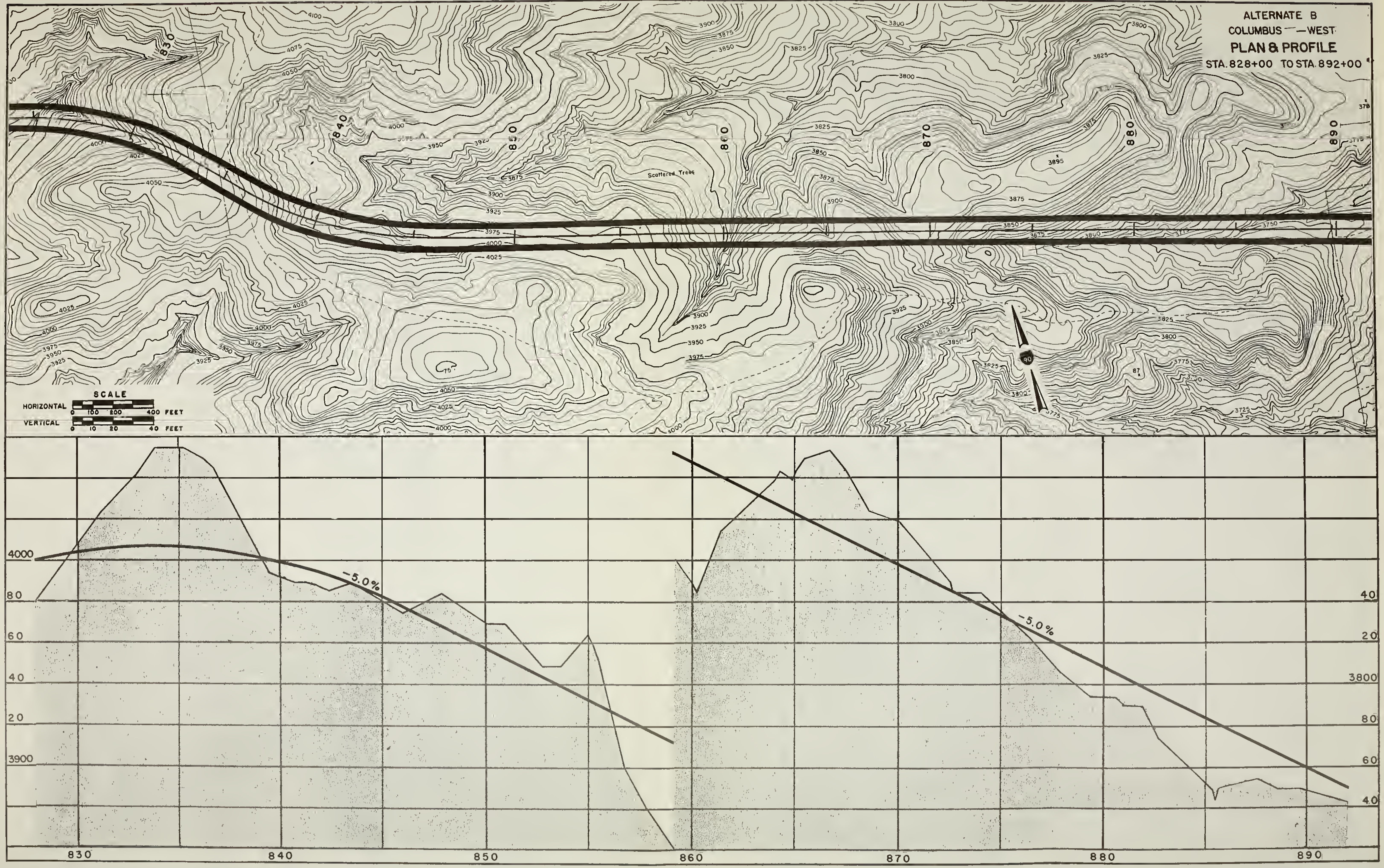
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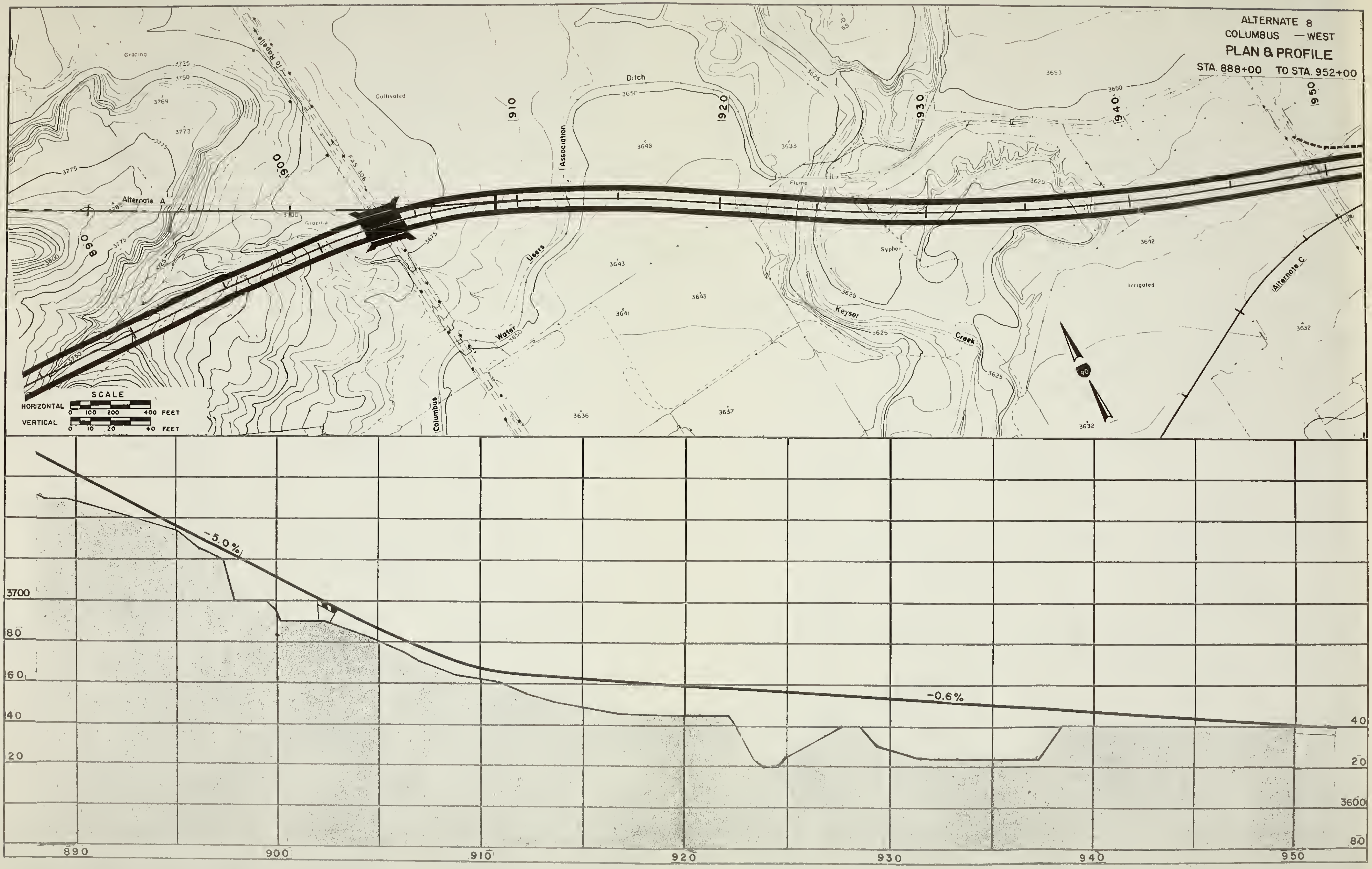
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COLUMBUS — WEST
PLAN & PROFILE
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To Rapelje
FAS 306
Grazing
Cultivated
Ditch
Flume
Syphon
Irrigated
Alternate A
Alternate C
Columbus Water Users Association
Keyser Creek
3725
3750
3769
3773
3775
3800
3700
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3650
3648
3643
3641
3636
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3633
3625
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3612
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90
890
900
910
920
930
940
950
SCALE
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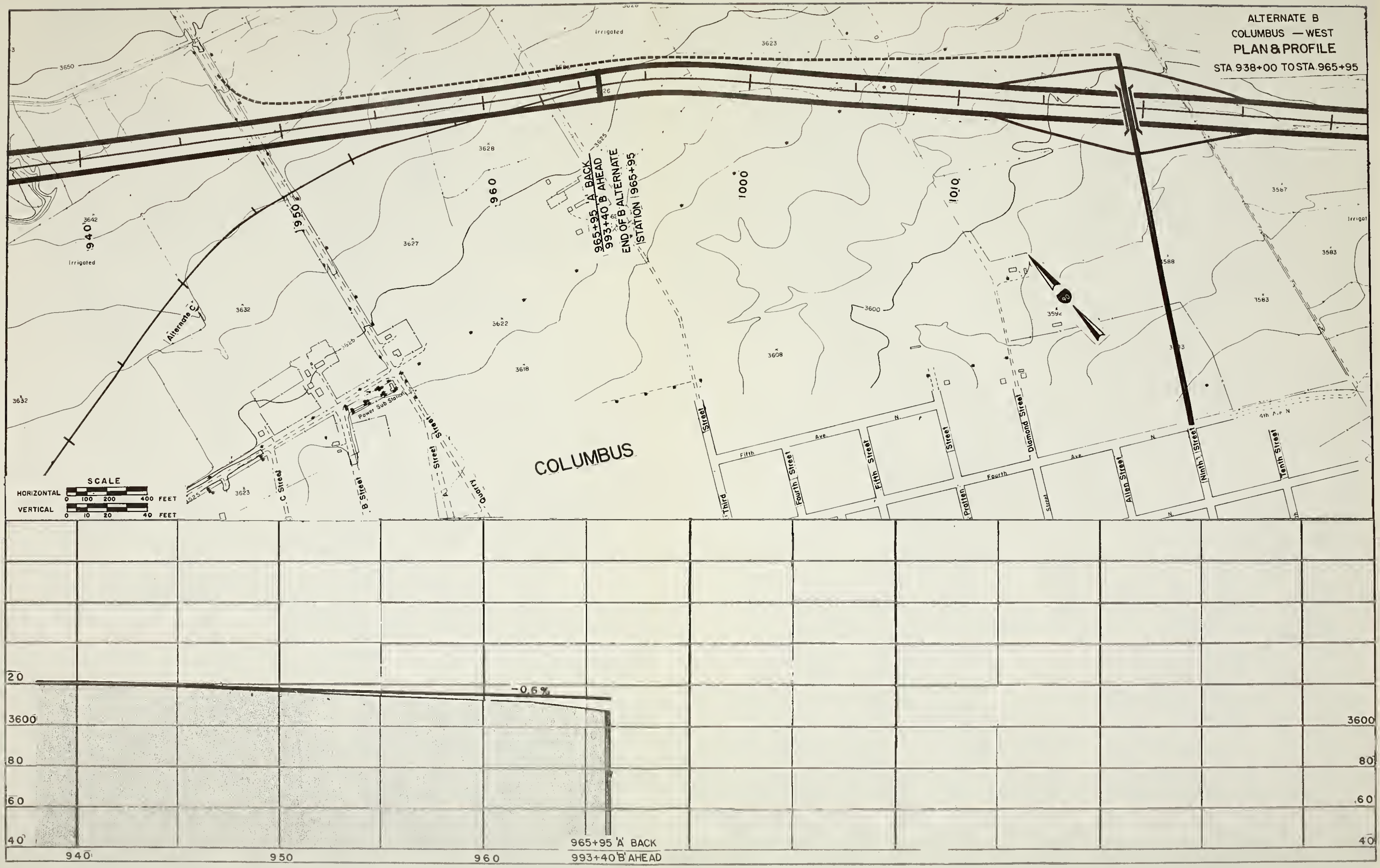
40
20
3600
80



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PLAN & PROFILE
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ALTERNATE C
COLUMBUS —WEST
PLAN & PROFILE
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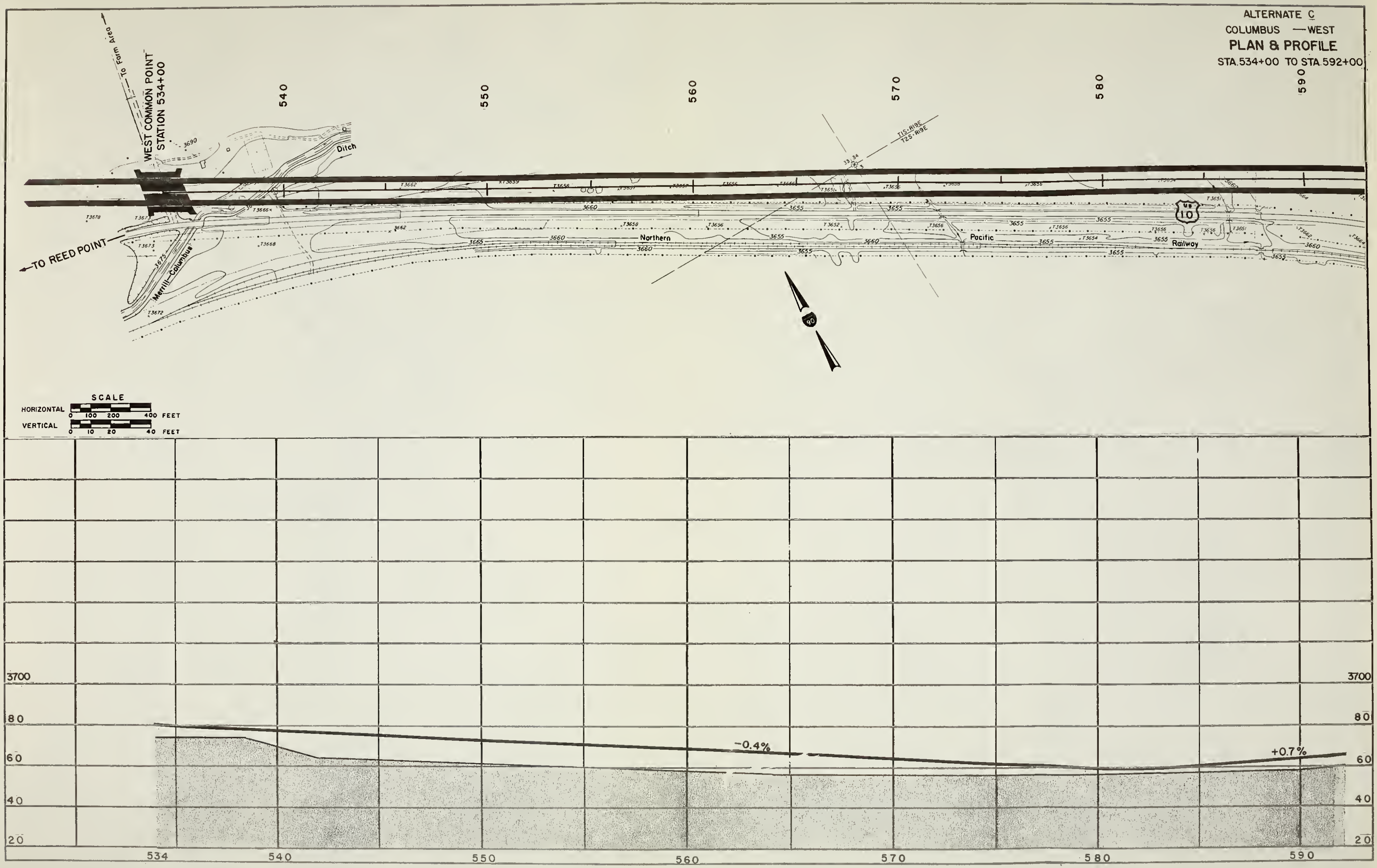

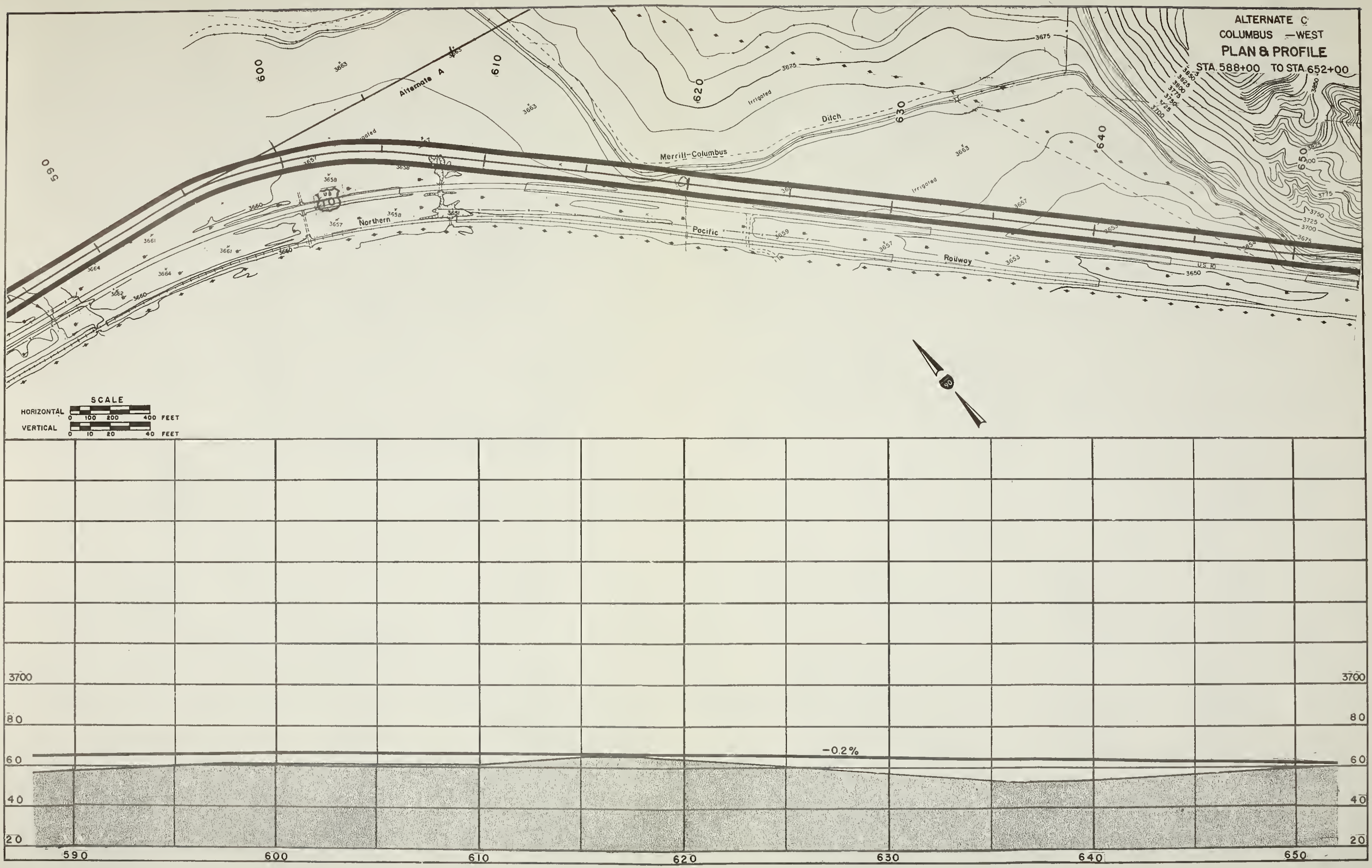
ALTERNATE C
COLUMBUS —WEST
PLAN & PROFILE
STA. 588+00 TO STA. 652+00
Alternate A
Merrill-Columbus
Ditch
Irrigated
Northern
Pacific
Railway
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VERTICAL 0 10 20 40 FEET
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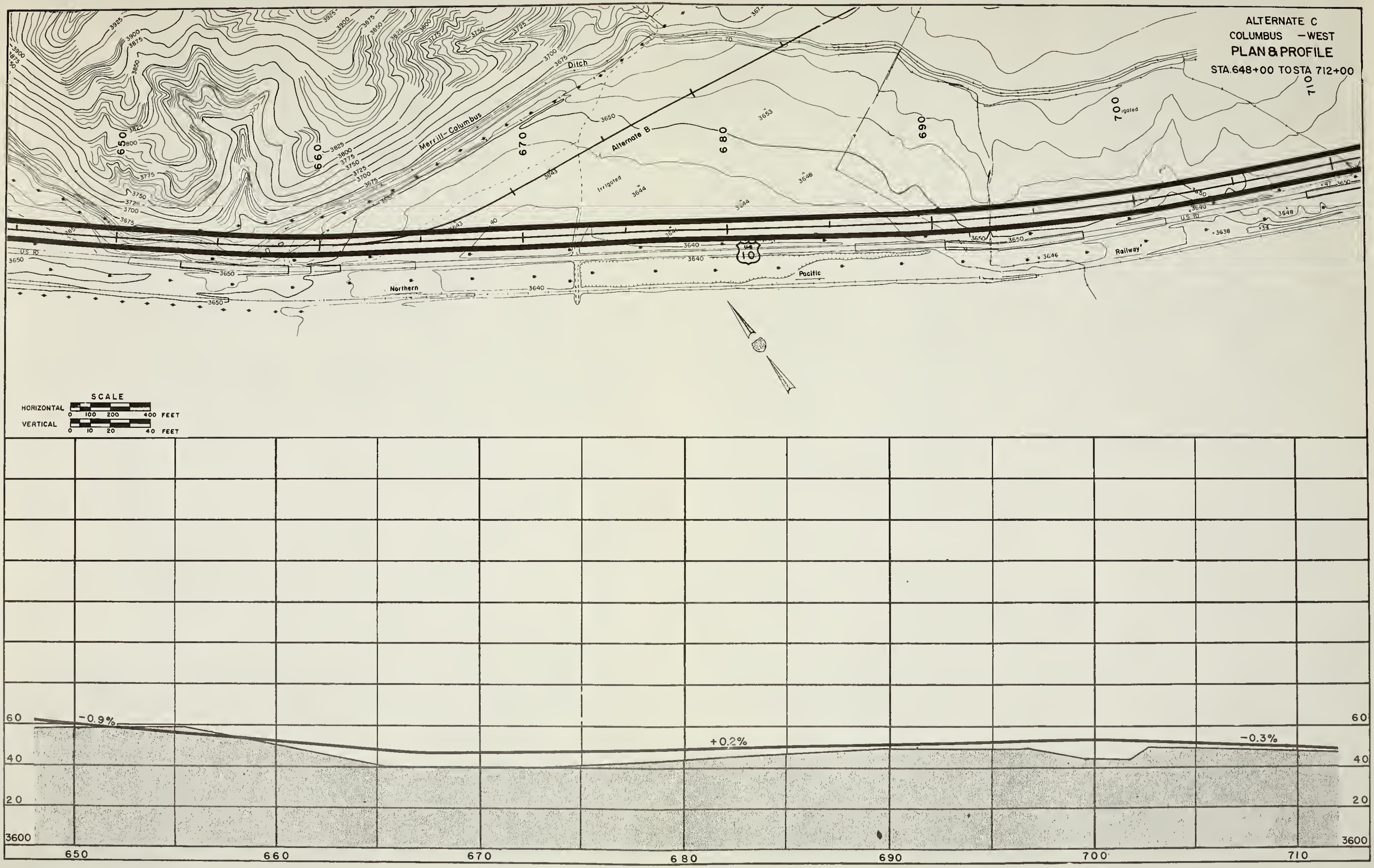

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PLAN & PROFILE
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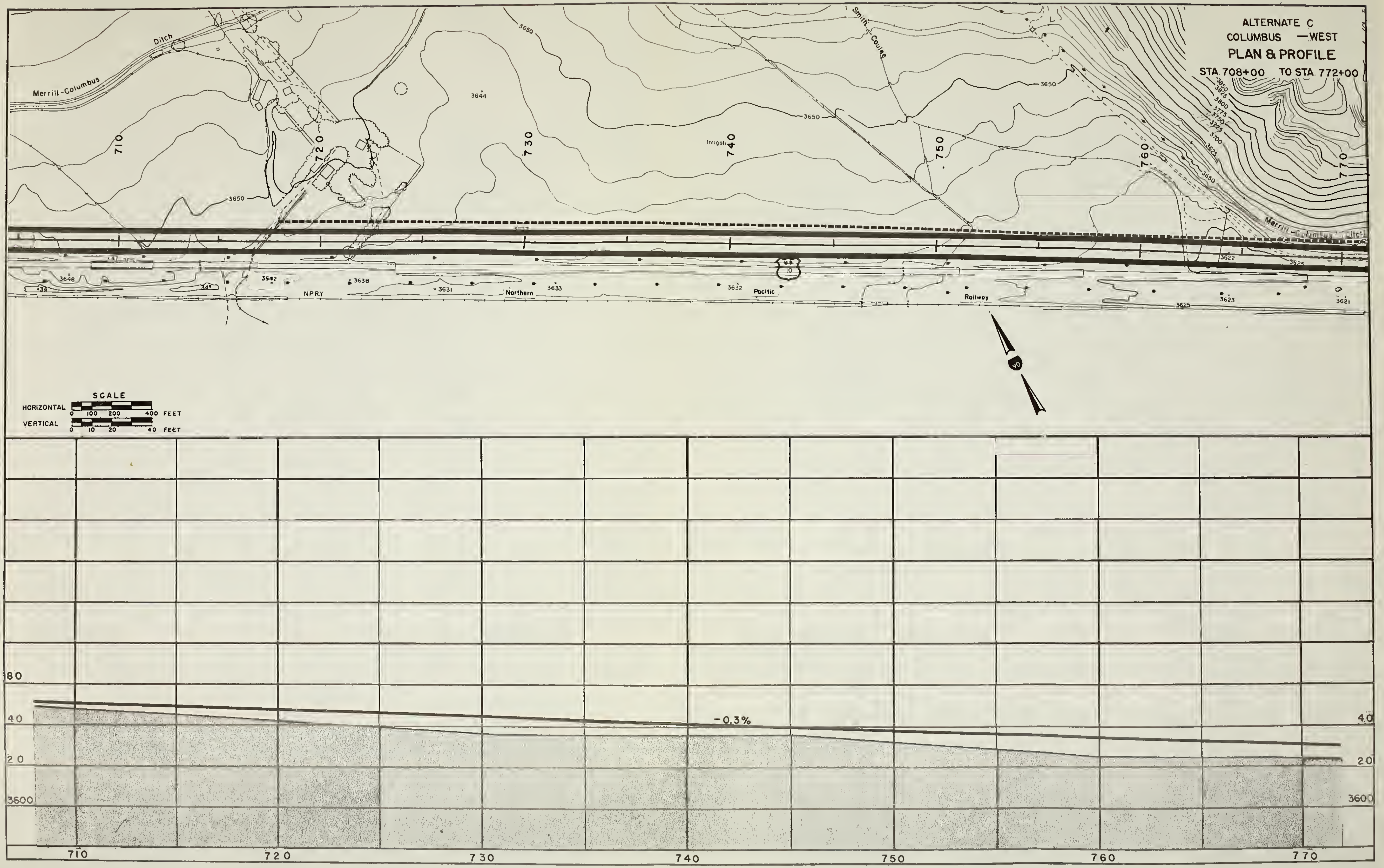

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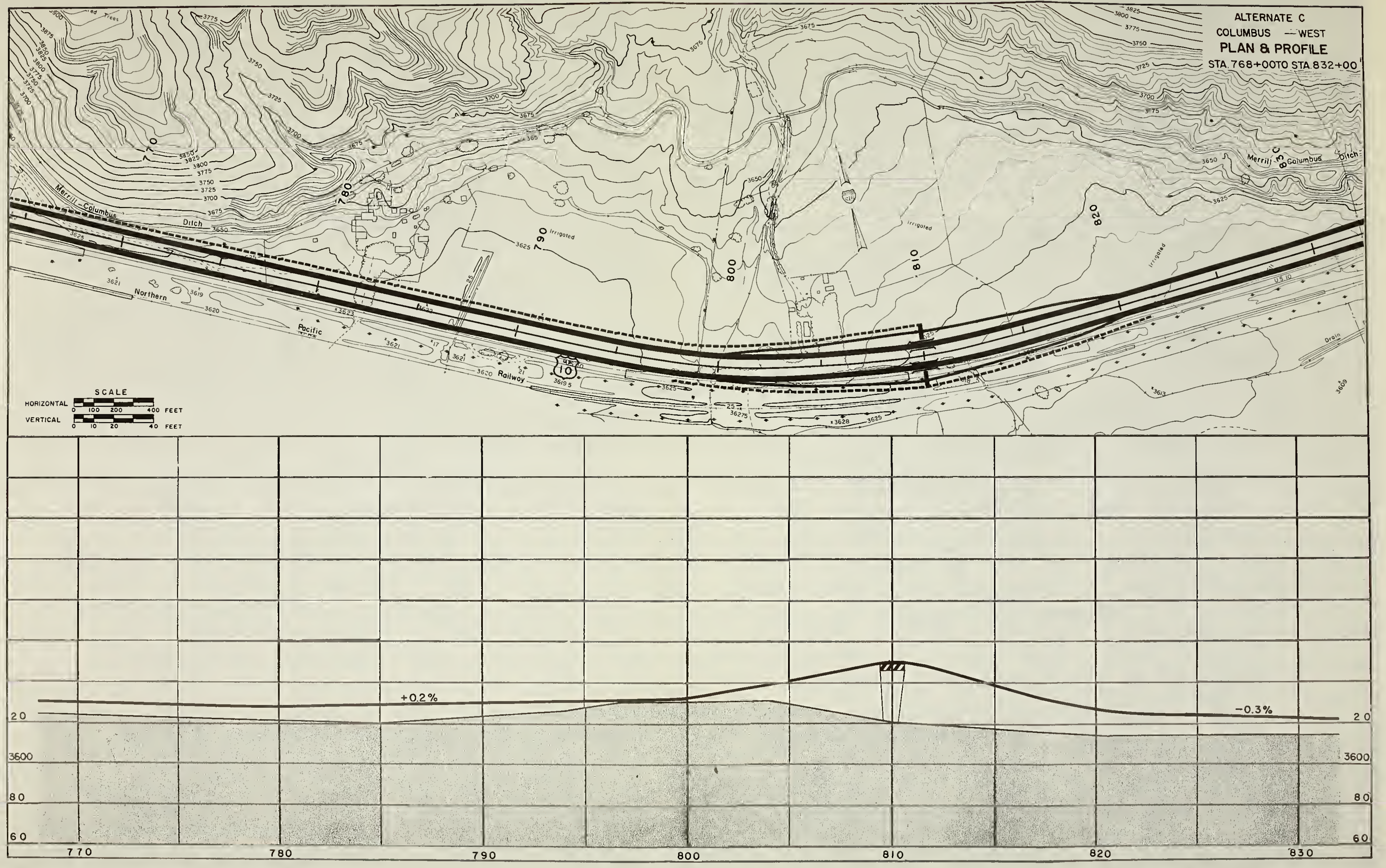
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COLUMBUS — WEST
PLAN & PROFILE
STA. 768+00TO STA. 832+00
Merrill - Columbus Ditch
Northern Pacific Railway
US 10
Irrigated
Drain
SCALE
HORIZONTAL
0 100 200 400 FEET
VERTICAL
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780
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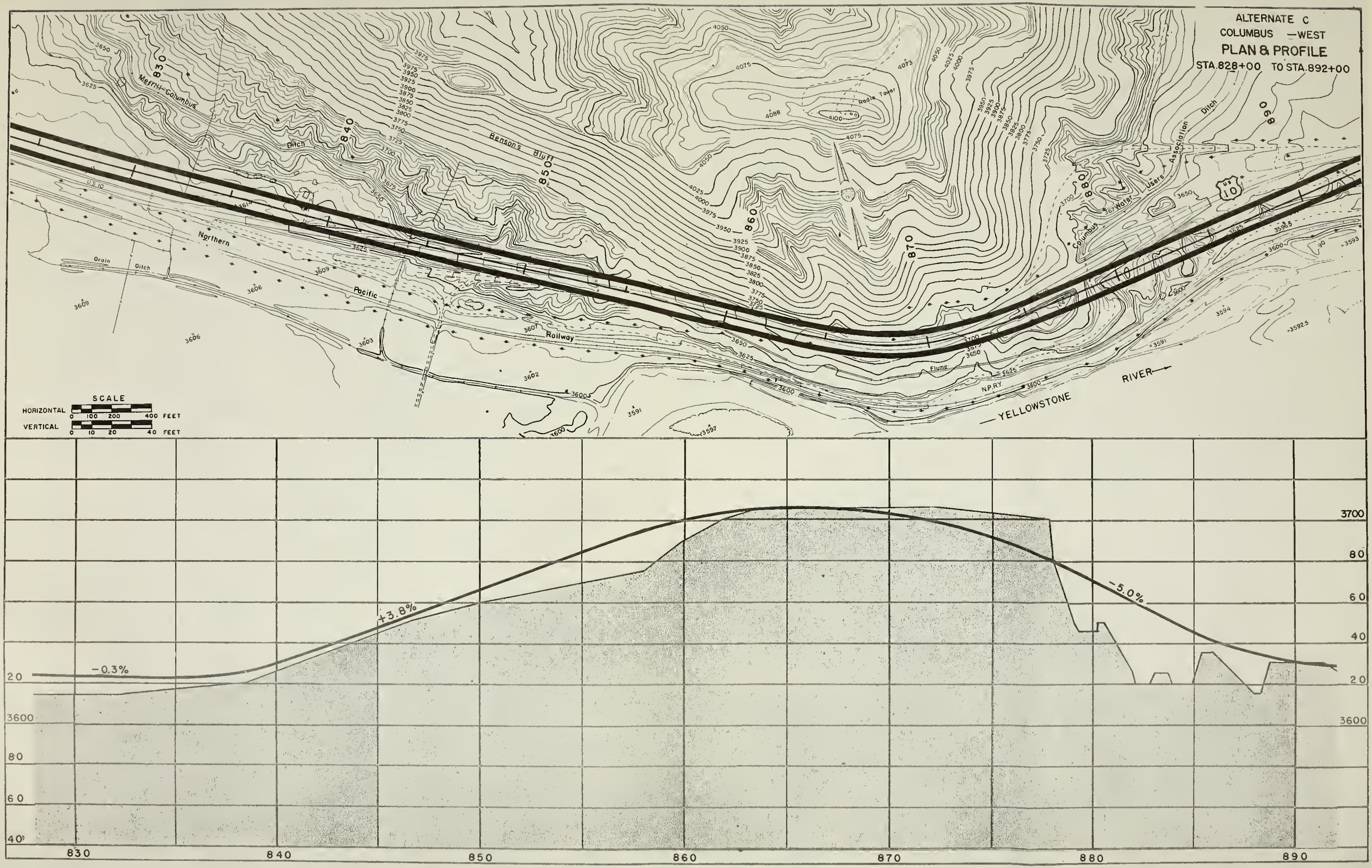
810
820
830
+0.2%
-0.3%
20
3600
80
60



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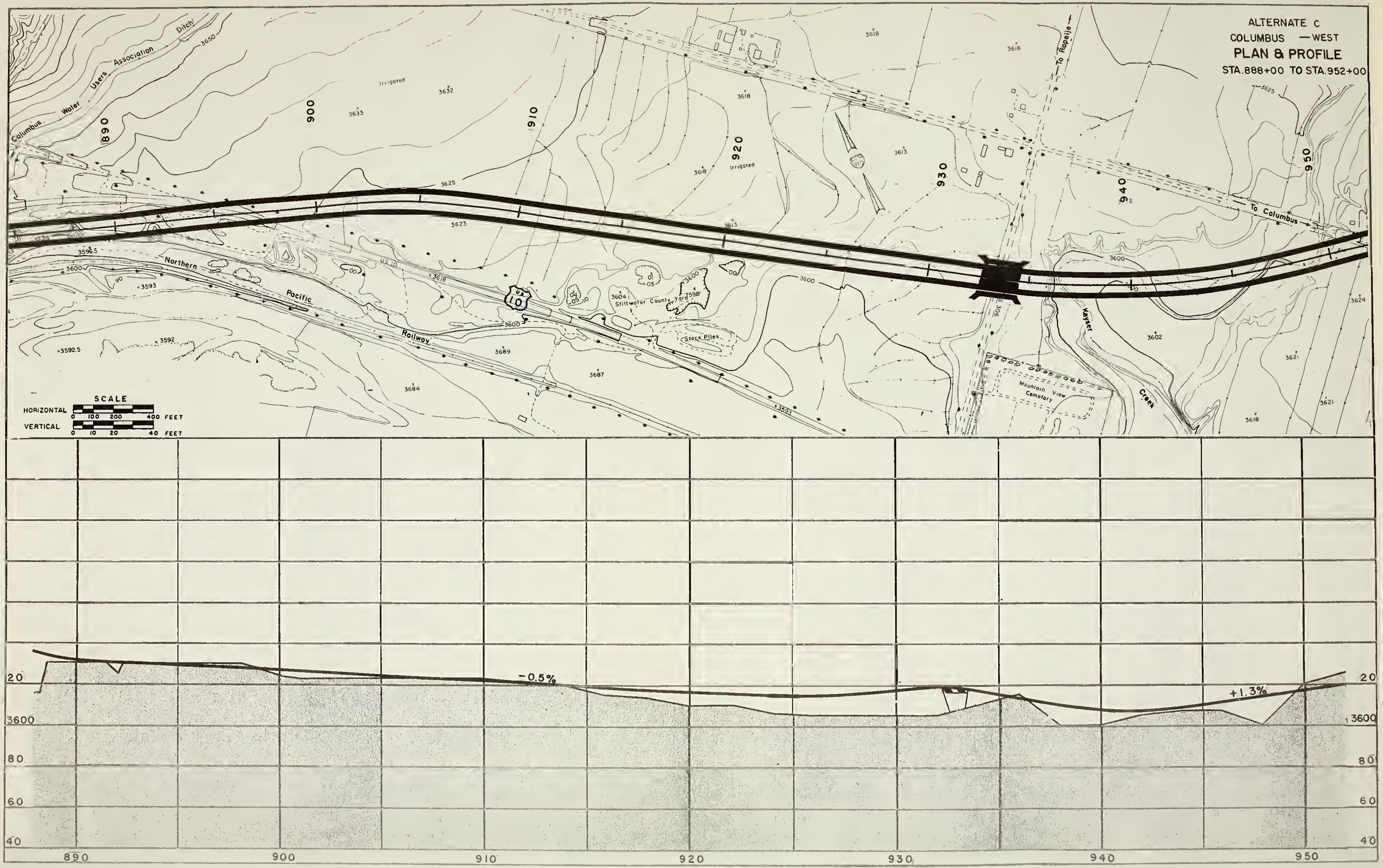

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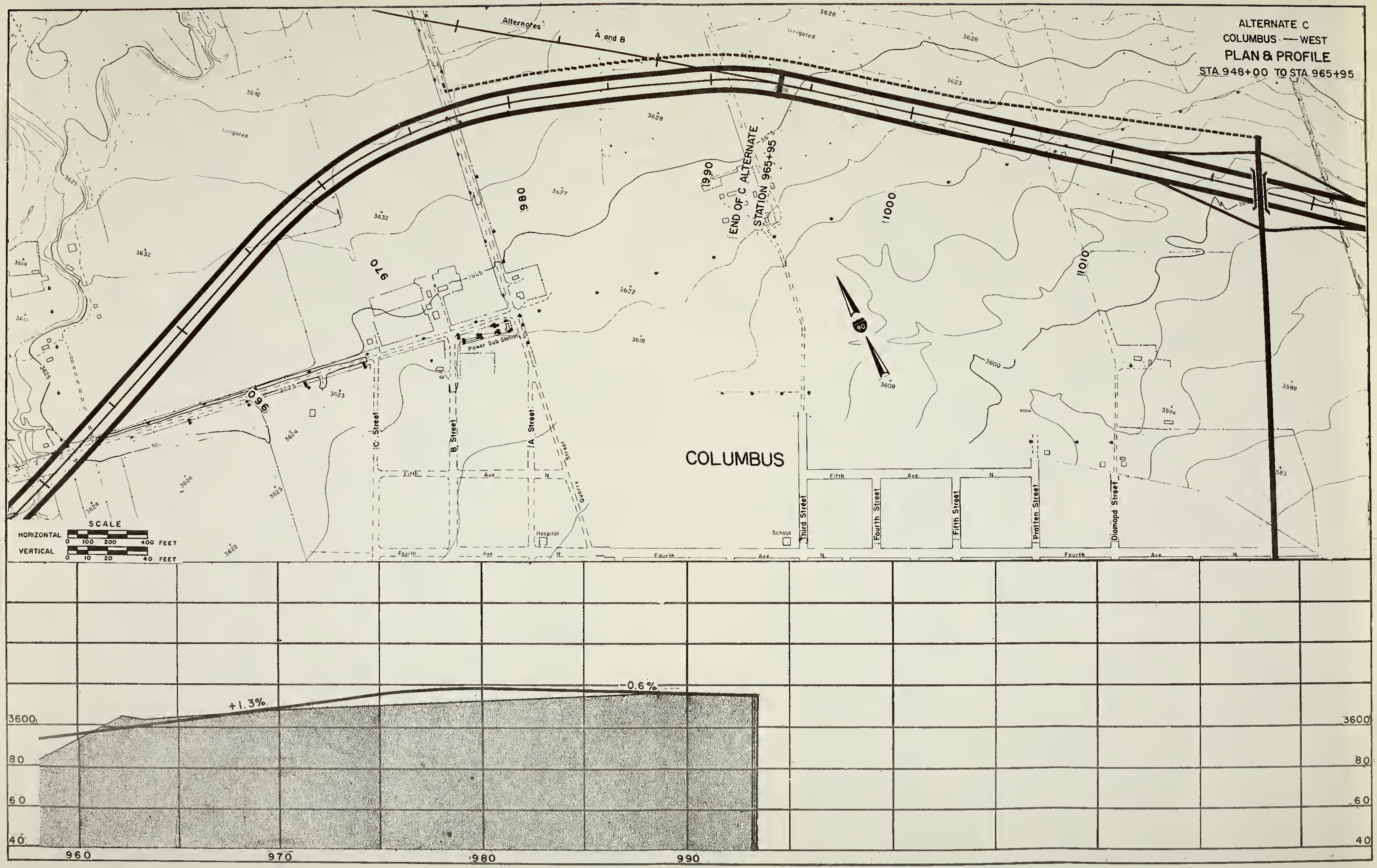
ALTERNATE C
COLUMBUS — WEST
PLAN & PROFILE
STA. 948+00 TO STA. 965+95
Alternates A and B
END OF C ALTERNATE
STATION 965+95
COLUMBUS
Irrigated
Power Sub Station
Hospital
School
C Street
B Street
A Street
Quarry Street
Third Street
Fourth Street
Fifth Street
Pratten Street
Diamond Street
Fifth Ave. N.
Fourth Ave. N.
90
960
970
980
990
1000
1010
3628
3623
3627
3632
3622
3618
3617
3612
3625
3624
3614
3600
3608
3588
3583
SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET
+1.3%
-0.6%
3600
80
60
40
960
970
980
990